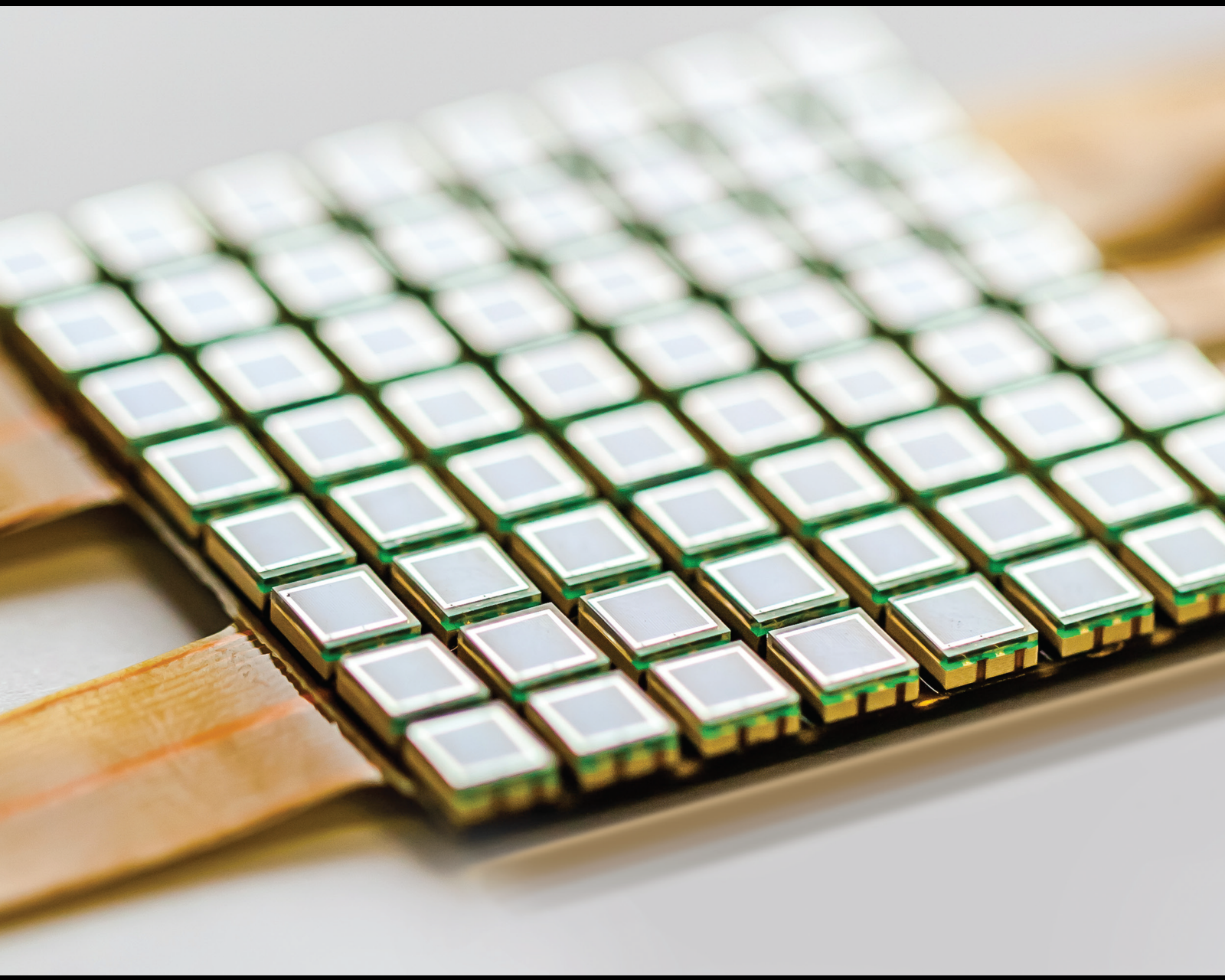
Journal of Sensors

Advanced Machine Learning Algorithms for Multi-Sensor Data Processing

Lead Guest Editor: Yaxiang Fan
Guest Editors: Yan Chai Hum and Zunera Jalil



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[Retracted] Hardware Optimization and System Design of Elliptic Curve Encryption Algorithm Based on FPGA
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[Retracted] Automatic Diagnosis of Elbow Arthritis Based on Edge Algorithm
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Retraction

Retracted: Design of New Working Environment Based on Artificial Intelligence Algorithm

Journal of Sensors

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The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] B. Zhou and L. Qu, "Design of New Working Environment Based on Artificial Intelligence Algorithm," *Journal of Sensors*, vol. 2022, Article ID 6130761, 11 pages, 2022.

Hindawi
Journal of Sensors
Volume 2024, Article ID 9898246, 1 page
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Retraction

Retracted: Use Brain-Like Audio Features to Improve Speech Recognition Performance

Journal of Sensors

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[1] J. Wang, B. Li, and J. Zhang, "Use Brain-Like Audio Features to Improve Speech Recognition Performance," *Journal of Sensors*, vol. 2022, Article ID 6742474, 12 pages, 2022.

Hindawi
Journal of Sensors
Volume 2024, Article ID 9898023, 1 page
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Retraction

Retracted: Construction and Application of Physical Education Teacher Literacy Evaluation System Based on Grey Relational Model

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[1] X. Kong and D. Guo, "Construction and Application of Physical Education Teacher Literacy Evaluation System Based on Grey Relational Model," *Journal of Sensors*, vol. 2022, Article ID 5448213, 12 pages, 2022.

Hindawi
Journal of Sensors
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Retraction

Retracted: Function Extraction Based on CFPS and Digital Financial Index: Data Mining Techniques for Prognosis of Operational Risks of Financial Institutions

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Hindawi
Journal of Sensors
Volume 2024, Article ID 9893120, 1 page
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Retraction

Retracted: The Relationship between Body Mass Index and Physical Activity Participation Rate Design Based on Fuzzy Breakpoint Regression Design

Journal of Sensors

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[1] J. Wu and L. He, "The Relationship between Body Mass Index and Physical Activity Participation Rate Design Based on Fuzzy Breakpoint Regression Design," *Journal of Sensors*, vol. 2022, Article ID 3721659, 11 pages, 2022.

Hindawi
Journal of Sensors
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Retracted: Deep Learning-Based ECG Abnormality Identification Prediction and Analysis

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[1] W. Liang, "Deep Learning-Based ECG Abnormality Identification Prediction and Analysis," *Journal of Sensors*, vol. 2022, Article ID 3466787, 9 pages, 2022.

Hindawi
Journal of Sensors
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Retraction

Retracted: Optimization and Quality Evaluation of Online Teaching Courses Based on Machine Learning

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References

[1] S. Li and M. Shi, "Optimization and Quality Evaluation of Online Teaching Courses Based on Machine Learning," *Journal of Sensors*, vol. 2022, Article ID 5081505, 12 pages, 2022.

Hindawi
Journal of Sensors
Volume 2024, Article ID 9826520, 1 page
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Retraction

Retracted: Research on the Use of Task-Based Language Teaching Method in English Language Teaching Based on Big Data 5G IoT Scenario

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[1] C. Xu, "Research on the Use of Task-Based Language Teaching Method in English Language Teaching Based on Big Data 5G IoT Scenario," *Journal of Sensors*, vol. 2022, Article ID 4926105, 11 pages, 2022.

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Hindawi
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Retraction

Retracted: Hardware Optimization and System Design of Elliptic Curve Encryption Algorithm Based on FPGA

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Retraction

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The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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Hindawi
Journal of Sensors
Volume 2024, Article ID 9759145, 1 page
https://doi.org/10.1155/2024/9759145

Retraction

Retracted: Analysis and Application of Quality Indicators in Hospital Administrative Management Based on a Fuzzy Hierarchical Model

Journal of Sensors

Received 23 January 2024; Accepted 23 January 2024; Published 24 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

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[1] H. Wang, "Analysis and Application of Quality Indicators in Hospital Administrative Management Based on a Fuzzy Hierarchical Model," *Journal of Sensors*, vol. 2022, Article ID 4222894, 13 pages, 2022.

Hindawi
Journal of Sensors
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https://doi.org/10.1155/2023/9896754

Retraction

Retracted: Display and Analysis of Virtual 3D Technology in Interior Design

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9874817, 1 page
https://doi.org/10.1155/2023/9874817

Retraction

Retracted: Markov Model-Based Sports Training Risk Prediction Model Design and Its Training Control

Journal of Sensors

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[1] H. Huang and S. Wen, "Markov Model-Based Sports Training Risk Prediction Model Design and Its Training Control," *Journal of Sensors*, vol. 2022, Article ID 9368686, 10 pages, 2022.

Hindawi
Journal of Sensors
Volume 2023, Article ID 9873926, 1 page
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Retraction

Retracted: Analysis of Digital Economy Development Based on AHP-Entropy Weight Method

Journal of Sensors

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[1] S. Yang and J. He, "Analysis of Digital Economy Development Based on AHP-Entropy Weight Method," *Journal of Sensors*, vol. 2022, Article ID 7642682, 8 pages, 2022.

Hindawi
Journal of Sensors
Volume 2023, Article ID 9872037, 1 page
https://doi.org/10.1155/2023/9872037

Retraction

Retracted: Analysis of Green Financial Policy Utility: A Policy Incentive Financial Mechanism Based on State Space Model Theory Algorithm

Journal of Sensors

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Hindawi
Journal of Sensors
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Retraction

Retracted: Abnormal Concentration Detection Method of Chemical Pollutants Based on Multisensor Fusion

Journal of Sensors

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9865967, 1 page
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Retraction

Retracted: Artificial Intelligence-Based Soccer Sports Training Function Extraction: Application of Improved Genetic Algorithm to Soccer Training Path Planning

Journal of Sensors

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[1] W. Zhang, "Artificial Intelligence-Based Soccer Sports Training Function Extraction: Application of Improved Genetic Algorithm to Soccer Training Path Planning," *Journal of Sensors*, vol. 2022, Article ID 8375916, 11 pages, 2022.

Hindawi
Journal of Sensors
Volume 2023, Article ID 9851941, 1 page
https://doi.org/10.1155/2023/9851941

Retraction

Retracted: Research Based on the Application and Exploration of Artificial Intelligence in the Field of Traditional Music

Journal of Sensors

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[1] Y. Yang and X. Huang, "Research Based on the Application and Exploration of Artificial Intelligence in the Field of Traditional Music," *Journal of Sensors*, vol. 2022, Article ID 5093044, 9 pages, 2022.

Hindawi
Journal of Sensors
Volume 2023, Article ID 9847837, 1 page
https://doi.org/10.1155/2023/9847837

Retraction

Retracted: Risk Assessment and Analysis in Supply Chain Finance Based on Blockchain Technology

Journal of Sensors

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9843730, 1 page
https://doi.org/10.1155/2023/9843730

Retraction

Retracted: Personalized Recommendation Evaluation of Credit Degree Based on New Hybrid Crow Search Algorithm for E-Commerce Live Industry Data Analysis

Journal of Sensors

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9841802, 1 page
https://doi.org/10.1155/2023/9841802

Retraction

Retracted: Mental Health Education in Primary and Secondary Schools Based on Deep Learning

Journal of Sensors

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[1] C. Wang and Y. An, "Mental Health Education in Primary and Secondary Schools Based on Deep Learning," *Journal of Sensors*, vol. 2022, Article ID 9672254, 5 pages, 2022.

Hindawi
Journal of Sensors
Volume 2023, Article ID 9834965, 1 page
https://doi.org/10.1155/2023/9834965

Retraction

Retracted: Discussion on the Network Literacy Education System of College Students under the Big Data Media Management Model

Journal of Sensors

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9832487, 1 page
https://doi.org/10.1155/2023/9832487

Retraction

Retracted: Applied Logic in the Age of Big Data: The Evolution of Linguistic Programming and Decoding in Psychological Trend Analysis

Journal of Sensors

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9826740, 1 page
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Retraction

Retracted: Software Engineering Code Workshop Based on B-RRT*FND Algorithm for Deep Program Understanding Perspective

Journal of Sensors

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9825321, 1 page
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Retraction

Retracted: Modal Analysis of Aeronautic Spiral Bevel Gear in the Temperature Field

Journal of Sensors

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Hindawi
Journal of Sensors
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Retraction

Retracted: Friction Performance Analysis of Reactor Coolant Pump Shaft Seal Based on Sensor and Computer Simulation

Journal of Sensors

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Hindawi
Journal of Sensors
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Retraction

Retracted: Industrial Information Security Detection and Protection: Monitoring and Warning Platform Architecture Design and Cryptographic Antitheft Technology System Upgrade

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[1] L. Wang, X. Guo, X. Zhang, and Z. Gang, "Industrial Information Security Detection and Protection: Monitoring and Warning Platform Architecture Design and Cryptographic Antitheft Technology System Upgrade," *Journal of Sensors*, vol. 2022, Article ID 1263330, 11 pages, 2022.

Hindawi
Journal of Sensors
Volume 2023, Article ID 9814067, 1 page
https://doi.org/10.1155/2023/9814067

Retraction

Retracted: On the Application of BIM Technology and Neural Network Algorithm in the Study of Energy-Saving Optimization of the Envelope Structure of Assembled Buildings in the Western Sichuan Plain

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

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(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9805236, 1 page
https://doi.org/10.1155/2023/9805236

Retraction

Retracted: Construction and Quality Control of Subway Wet Loess in Concealed Tunnel Based on Particle Swarm Optimization Algorithm

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9803506, 1 page
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Retraction

Retracted: Optimization of Color Enhancement Processing for Plane Images Based on Computer Vision

Journal of Sensors

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[1] Y. Jiao, "Optimization of Color Enhancement Processing for Plane Images Based on Computer Vision," *Journal of Sensors*, vol. 2022, Article ID 3654743, 9 pages, 2022.

Hindawi
Journal of Sensors
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Retraction

Retracted: Personalized Book Recommendation Algorithm for University Library Based on Deep Learning Models

Journal of Sensors

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9793431, 1 page
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Retraction

Retracted: Analysis of Multiple Linear Regression Algorithm for High Quality Development Factors of Cross-Border E-Commerce

Journal of Sensors

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9790567, 1 page
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Retraction

Retracted: Two-Stage Research on AC/DC Hybrid High-Voltage Distribution Network Based on Network Reconfiguration and SOP Coordinated Control

Journal of Sensors

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9781469, 1 page
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Retraction

Retracted: Edge Node Aware Adaptive Data Processing Method for Ubiquitous NB-IoT

Journal of Sensors

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9780195, 1 page
https://doi.org/10.1155/2023/9780195

Retraction

Retracted: Spatial Expression of Multifaceted Soft Decoration Elements: Application of 3D Reconstruction Algorithm in Soft Decoration and Furnishing Design of Office Space

Journal of Sensors

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9769243, 1 page
https://doi.org/10.1155/2023/9769243

Retraction

Retracted: Determination of Evidence Weights Based on Convolutional Neural Network for Classification Problem

Journal of Sensors

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9765904, 1 page
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Retraction

Retracted: Risk Mechanism and Architecture of Investment and Financing Based on DEA-Malmquist Index

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

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[1] J. Chu, "Risk Mechanism and Architecture of Investment and Financing Based on DEA-Malmquist Index," *Journal of Sensors*, vol. 2022, Article ID 3613624, 10 pages, 2022.

Hindawi
Journal of Sensors
Volume 2023, Article ID 9760709, 1 page
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Retraction

Retracted: Parameter Optimization and Performance Analysis of Composite Substance That Can Prevent Burning Based on Machine Learning

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

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[1] Z. Qiu-yu, Y. Huahao, W. Tianming, D. Lihui, and H. Rui, "Parameter Optimization and Performance Analysis of Composite Substance That Can Prevent Burning Based on Machine Learning," *Journal of Sensors*, vol. 2023, Article ID 5732097, 11 pages, 2023.

Hindawi
Journal of Sensors
Volume 2023, Article ID 9852724, 1 page
https://doi.org/10.1155/2023/9852724

Retraction

Retracted: Intelligent Building Space Layout and Optimization Design Method Based on Biological Population Simulation

Journal of Sensors

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[1] C. Wu and Y. Lin, "Intelligent Building Space Layout and Optimization Design Method Based on Biological Population Simulation," *Journal of Sensors*, vol. 2022, Article ID 6246576, 9 pages, 2022.

Hindawi
Journal of Sensors
Volume 2023, Article ID 9808615, 1 page
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Retraction

Retracted: Development and Utilization of English Online Course Resources Based on Fuzzy Neural Network

Journal of Sensors

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9898430, 1 page
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Retraction

Retracted: Research on Collaborative Innovation of Supply-Side Reform of University Ideological and Political Education Based on Intelligent Big Data Information Fusion

Journal of Sensors

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9896131, 1 page
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Retraction

Retracted: Analysis on the Coupling Relationship between Natural Resource Loss and Environmental Pollution Cost Accounting in Chongqing

Journal of Sensors

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9872157, 1 page
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Retraction

Retracted: Design of Intelligent Nursing System Based on Artificial Intelligence

Journal of Sensors

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9856950, 1 page
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Retraction

Retracted: An Analysis of the Influence of Complex Networks in Cross-Cultural Communication

Journal of Sensors

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Hindawi
Journal of Sensors
Volume 2023, Article ID 9821587, 1 page
https://doi.org/10.1155/2023/9821587

Retraction

Retracted: Research on Intelligent Scoring and Style of Calligraphy Post Based on Machine Vision

Journal of Sensors

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We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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Retraction

Retracted: Analysis of Human Resource Allocation Scheme for Digital Media Big Data Based on Recurrent Neural Network Model

Journal of Sensors

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Retraction

Retracted: Corporate Financing Constraints and Information Disclosure: An Analysis of Corporate Investment Dilemmas under the Wave of Counter-Globalization

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Retraction

Retracted: Hybrid Encryption Algorithm for Sensitive Information of College Physical Fitness in Cloud Storage Environment

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Retraction

Retracted: A Study on the Design of English Speaking Examination System Based on SSM Framework

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Retraction

Retracted: Parameter Optimization and Performance Analysis of Composite Substance That Can Prevent Burning Based on Machine Learning

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(6) Manipulated or compromised peer review

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[1] Z. Qiu-yu, Y. Huahao, W. Tianming, D. Lihui, and H. Rui, "Parameter Optimization and Performance Analysis of Composite Substance That Can Prevent Burning Based on Machine Learning," *Journal of Sensors*, vol. 2023, Article ID 5732097, 11 pages, 2023.

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Research Article

Parameter Optimization and Performance Analysis of Composite Substance That Can Prevent Burning Based on Machine Learning

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In the past 30 years, a substance that can prevent burning has played an important role in reducing the loss of life and property caused by fire. At present, the total amount of antibaking agent is second only to plasticizer and various plastic additives in the world. With an average annual growth rate of 0.5% from 2019 to 2021. The fire protection industry is a regulatory industry and a globally competitive industry. Therefore, the entry into force and gradual improvement of relevant laws and regulations at home and abroad will affect the pattern of the whole fire protection industry. China's "Twelfth Five-Year Plan" will bring a substance that can prevent burning into key development industries and form a strategic alliance for technological innovation of green substance that can prevent burning industries. It provides a policy platform for the development of a substance that can prevent burning in industry. Firstly, we introduce several common a substance that can prevent burnings, then we use machine learning method to establish prediction model and to analyze the performance of composite combustibles. And draw the conclusion: composite material is better than the other two composites; among the six machine learning algorithms, the gradient boosting regression (GBR) model has the best prediction ability, followed by the extra tree regressor (ETR) model and the random forest regressor (RFR) model. Compared with the above three integrated algorithms, Ridge, Ada Boost regressor (ABR), and Lasso regression algorithms have relatively poor prediction results.

1. Introduction

We propose a two-stage machine learning method to predict protein-protein interaction. We train machine learning classifiers to predict the interaction of binary fragments between two short sequence fragments. Experimental results show that, compared with other sequence representation methods, the multiscale sequence feature aggregation method's effect can be improved by more than 10% [1]. Apache Spark is a popular practical platform for large-scale computing, which is very suitable for iterative machine computing research. Spark's open-source distributed machine learning library (MLlib) technology has been discovered in recent years. MLlib provides Spark's high-level multilingual API schema and simplifies end-to-end development for machine learning using Spark's rich ecosystem. [2]. Machine learning is one of the fastest-developing researches in the computer field, and its application range is wide. This paper introduces the concepts of computational complexity. convexity, and stability in learning. Key algorithm paradigms include stochastic gradient calculation, neural network, and structured learning of results [3]. Protein database growth, combined with neural networks, hidden Markov models, and other machine methods, makes it possible to achieve a certain degree of reliability. Finally, we briefly review several methods to predict other protein classification signals and look forward to the future of protein classification prediction [4]. The support vector machine classification algorithm is a new development in the field of machine learning, and it has potential application prospects in structure-activity relationship analysis. SVM is compared with several machine learning technologies currently used. Support vector machine is much

better than all these except artificial capacity control neural network, which take longer to train [5]. In the research on network intrusion detection, a popular strategy to detect attacks is to monitor the network for abnormal activities, which are usually identified by borrowing tools from the machine learning community. We explore the differences between the problem of network intrusion detection and other areas where machine learning is often more successful [6]. The flame retardancy and a substance that can prevent burning mechanism of asphalt mortar containing composite a substance that can prevent burning materials were studied by the limiting oxygen index method, thermogravimetry, differential scanning calorimetry, and smoke density method. The results show that the LOI of M-FR asphalt mortar can be increased by 5.9 [7]. A material that can prevent the combustion of additives provides a good solution for reducing the combustibility of composite materials thereby reducing the associated hazards. The comparison between simple mathematical equations and combustion test results shows that whether they can reasonably repeat experimental ignition parameters with composite materials that can prevent combustion depends on the mechanism of the materials, especially the combustion stage of designing a substance that can prevent burning activity [8]. Polypropylene composites were prepared with kaolin, magnesium hydroxide, or ammonium polyphosphate as fillers. The results show that the performance of the antiburning substance is improved with an increase in its amount of the antiburning substance. The flame retardant effect of different inorganic flame retardants is better than that of a single flame retardant, and the mechanical properties will not be significantly reduced [9]. This paper focuses on two different methods of obtaining phosphorus-modified epoxy materials for printed circuit boards with high performance. Compared with the new phosphorus-modified material, the Tg value is lower, and the substance that can prevent burning effect is worse. In order to explain the excellent flame suppression activity of phosphorus ring compounds, the decomposition behaviors of DOPO, DPPO, and their sulfur derivatives were studied by thermal desorption mass spectrometry and high resolution mass spectrometry [10]. Nonparticle-size organobentonite was synthesized by the intercalation modification of organophosphorus substance that can prevent burning and quaternary ammonium salt. The ability to prevent combustion and mechanical properties of these materials were characterized. The modified nano-OMMT has large interlayer spacing and good dispersion [11]. The effects of sosoloid and ATH composites on flame retardancy, physical properties, and thermal stability of PVC sheathing materials were studied in this paper. The experimental results show that the composite has high a substance that can prevent burning and has smoke suppression properties for PVC materials [12]. By selecting the appropriate nonlinear PI controller, the dynamic performance of the thermal process control system can be significantly improved. Simulation results show that one of the selected four nonlinear PI controllers can significantly improve the dynamic performance of four typical thermal process control systems and have the advantages of short-term stability time, small overshoot, smooth transition process, and robustness to parameter perturbation [13]. In order to ensure the validity and usability of the model, a unit-based dynamic analysis method for moving mass vehicles is proposed. The simplified equations are affine nonlinear equations. The impact angle deviation is within 0.01 of the position response of the accuracy equation. Thereby reducing the technical difficulty of autopilot design [14]. The real parameter constraint problem is an important optimization problem, which is often encountered in various problems in the real world. The standard format for genetic participants is not limited. Introducing appropriate processing techniques to extend GA problems to constrained optimization problems is an active direction of GA research [15]. The method adopted in this paper has the following research significance: (1) machine learning is a multidisciplinary and interdisciplinary, involving probability theory, statistics, approximation theory, convex analysis, algorithm complexity theory, and other disciplines. It specializes in how computers simulate or realize human learning behavior, in order to acquire new knowledge or skills, and reorganize existing knowledge structure to continuously improve its own performance. (2) It is the core of artificial intelligence and the fundamental way to make computers intelligent. In terms of the forecasting methods used, at present, the prediction methods of fabric properties after radiation aging focus on the application of statistical models and empirical equations. Although some scholars have established a statistical prediction model for the tensile strength of the outer fabric of fire-fighting clothing or established a linear equation between the tensile strength and the reflective coefficient of the fabric by numerical simulation, which provides suggestions for the maintenance of fire-fighting clothing to a certain extent, the above methods have limitations. Firstly, the tensile strength of flame retardant fabrics after thermal aging is affected by many factors, and the relationship between tensile strength and a single variable (thermal exposure time or thermal aging temperature, etc.) cannot fully cover the situation that leads to the decline of the tensile strength of fabrics. Secondly, the regression model established by statistical analysis not only has relatively poor prediction accuracy but also needs specific input parameters. If new variables are added, the model needs to be reestablished, which leads to a limited application range of the model and increases the experimental workload and time cost. Therefore, it is necessary to explore a new modeling method to make up for the shortcomings of previous modeling methods, which can not only reduce the time cost but also improve the prediction accuracy and application range of the model and provide technical suggestions for the selection and maintenance of firefighting clothing.

2. Introduction of Common Substance That Can Prevent Burnings

2.1. Halogen: A Substance That Can Prevent Burnings. According to the mechanism of the free radical chain reaction, halogen, a substance that can prevent burning, mainly

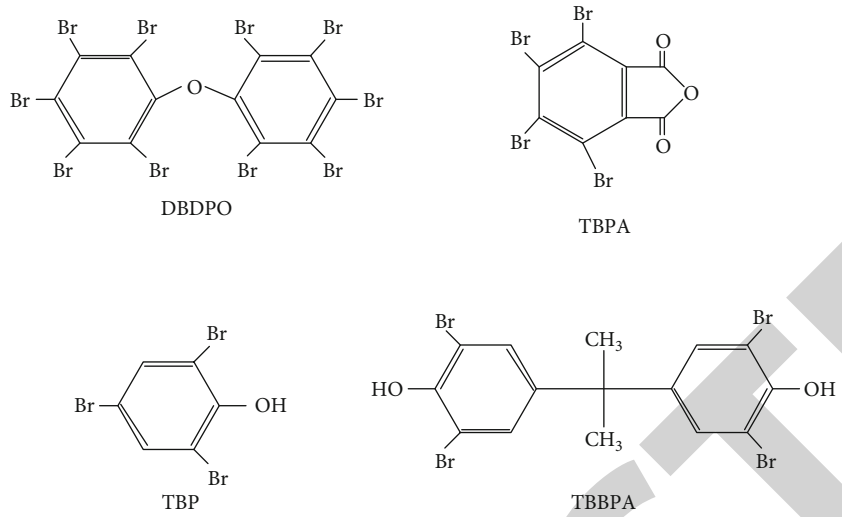

Figure 1: Chemical structures of several halogens.

plays a chemical disturbance role in the gas phase combustion process (for example).

$$RX \longrightarrow R\cdot + X\cdot, \quad (1)$$

$$X\cdot + R\square H \longrightarrow R\square\cdot + HX, \quad (2)$$

$$HX + H\cdot \longrightarrow H_2 + X\cdot, \quad (3)$$

$$HX + OH\cdot \longrightarrow H_2O + X\cdot, \quad (4)$$

where RX is a halogenated hydrocarbon.

Halogen-based a substances that can prevent burning are mainly chlorine-containing compounds and bromine-containing compounds because they will decompose into halogen-containing free radicals during combustion. The thermal stability of fluorinated compounds is too high; free radicals are difficult to release; and the substance that can prevent the burning effect is difficult to achieve. The thermal stability of iodine-containing compounds is too low and unstable during the processing of most polymers. In industry, halogenated substances that can prevent burnings such as decabromodiphenyl ether, 2,3,6-tribromophenol, tetrabromophthalic anhydride, and tetrabromobisphenol have been widely used in polymers, as shown in Figure 1.

These substances, which are added to prevent combustion, are generally small, and the cost can be further reduced by incorporating small amounts of synergists such as antimony oxide and iron oxide. However, the use of most halogenated substances that can be protected from combustion is limited by their inherent toxicity, such as the formation of polybrominated dioxins and furans during combustion, which can have serious consequences for ecosystems. In addition, they also release a large amount of corrosive gases, such as hydrogen chloride, which can corrode metal parts and damage electronic equipment, thus causing disastrous consequences in a typical enclosed space such as a fuselage or naval hood.

2.2. Phosphorus: A Substance That Can Prevent Burnings

2.2.1. Red Phosphorus. Red phosphorus is a kind of phosphorus substance that can prevent burning, which is usually used in a small amount and has a good effect on polyester, polyurethane, nylon, and other materials. For example, glass fiber-reinforced nylon 66 can reach UL-94 V-0 grade only by adding 6-8% red disc. The results show that in most polymers, red phosphorus has a substance that can prevent burning in the condensed phase, and in some polymers, it has a substance that can prevent burning in the condensed phase and a substance that can prevent burning in the gas phase. The specific situation varies from a substance that can prevent burning to a substance that can prevent burning. In polyester, nylon, and other oxygen-containing polymer materials, red phosphorus mainly plays the role of a substance that can prevent burning in the condensation phase and oxidizes into phosphoric acid to form polymers as heat insulation and oxygen insulation material. Carbon fiber flooring for hydrocarbon polymers such as polyethylene and red discs can be a substance that can prevent combustion in the gas phase or a substance that can prevent combustion in the condensed phase. In addition to promoting carbonization, phosphorus and oxygen such as red phosphorus can prevent the chain reaction of free radicals and release free radicals during combustion. In addition, when red phosphorus is used together with a small amount of metal hydroxides, the substance that can prevent burning efficiency is greatly improved. Although red phosphorus has good flame retardancy, its use is limited due to insufficient hazardous treatment and its dark color.

2.2.2. Inorganic Phosphates. Ammonium polyphosphate is the most typical inorganic polymer phosphate. It is well known that when used in polyurethane, nylon, and other polymer materials containing nitrogen or oxygen elements, the carbon layer is combined to produce a fire prevention effect. APP can change its degradation mechanism. The

addition of APP at the same time of combustion prevents PMMA from "depolymerizing" and from burning.

2.2.3. Organophosphorus Compounds. At present, there are three kinds of organophosphorus compounds used as substance that can prevent burning: phosphate, phosphonate, and hypophosphite. The most common substance that can prevent burning in phosphonate is dimethyl methyl phosphonate, which is mainly used in thermosetting resin. At present, most hypophosphite a substance that can prevent burning are represented by metal hypophosphite, such as magnesium hypophosphite, hypophosphite, aluminum, and rare earth hypophosphite., which are used in polyester materials and have considerable substance that can prevent burning effect. It is shown in Figure 2.

2.3. Nitrogen-Containing Substance That Can Prevent Burnings. Melamine and its derivatives are the most commonly used nitrogen-containing substance that can prevent burnings. Phosphorus-containing melamine salts such as MPP and MCA release phosphoric acid when heated, which can acidify and dehydrate polymer matrix into carbon, so these substance that can prevent burning can play a similar role as other phosphorus-containing substance that can prevent burning. A substance that prevents burning has the effect of substance that prevent burning. In addition, in the case of melamine salts containing phosphorus, phosphoric acid formed in decomposition can further react to form phosphorus oxynitride at a temperature above 600°C and cross-link through rings. Triazine ring opening reaction is well known that phosphorus oxynitride is highly thermally stable and can be used in polymer materials. MP, MCA, and MPP are widely used in processing high-temperature polymer materials, such as polyamide, polyester, and some polyolefins.

2.4. Silicon-Containing Substance That Can Prevent Burnings

2.4.1. Polyhedral Oligomeric Silsesquioxane. POSS is a kind of promising polymer nanostructured filler, with a general formula $(RSiO1.5)n$, where n is even and R is substituent. Some monosubstituted POSS compounds have been successfully prepared by relevant experts. These POSS compounds can be dissolved in water and can also participate in conventional polymerization reactions such as free radical polymerization. It has a unique organic-inorganic cubic hybrid structure, and its size is comparable to that of several polymer materials. Therefore, the addition of POSS to thermoplastics or thermosetting plastics will affect the flow of structures, improve oxygen permeability, reduce flammability, and improve mechanical properties. The above performance improvement is beneficial to the use of materials in a wider range of fields.

2.4.2. Linear Silanes/Siloxanes. With the increasing safety requirements for polymer materials, the identification of new silicon-containing substance that can prevent burnings has been promoted. Two different forms (powder and liquid) of amine epoxy and methacrylate-functionalized linear siloxane have been added to study the flame retardancy of polyurethane elastomers. The experimental results show that the maximum thermal efficiency of the material can be

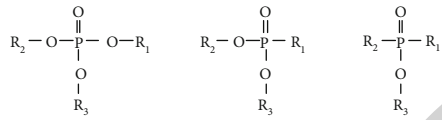

Figure 2: Chemical structural formula of organophosphorus a substance that can prevent burning.

reduced by 70-80% by adding 5% ground siloxane. Adding the same amount of liquid siloxane can reduce the maximum heat output by 49-78%. Hydroxyl-terminated polydimethylsiloxane can be directly used in epoxy resin system. After adding PDMS, the boundary oxygen index increases significantly.

2.5. Intumescent: A Substance That Can Prevent Burning. Intumescent, a substance that can prevent burnings, have only appeared in recent years, and the heat has not dropped so far. In this system, the polymer material expands by heat and fire to form a porous carbon layer. Compared with ordinary carbon layer, this porous expanded carbon layer has superior heat insulation, oxygen insulation, diffusion prevention of rupture products, and has a very good substance that can prevent burning effect. Under normal circumstances, forming an expandable fire protection system requires three elements: acid sources, mainly phosphorus-based compounds; carbon source; and gas sources, mainly used for flotation.

Intumescent, a substance that can prevent burning, has remarkable a substance that can prevent burning effect. In addition, intumescent, a substance that can prevent burnings, can be used in combination besides acting alone. For example, the app+PER system was added together with zeolite, and the results showed that zeolite was helpful in improving the flame retardancy of the app+PER stability. Therefore, it is also a good substance that can prevent burning method to use intumescent substance that can prevent burning together with synergist.

2.6. Metal Hydroxides. The metal hydroxide separates and releases water near the polymer decomposition temperature, and the aluminum hydroxide decomposes endothermally at 180-200°C and releases water molecules according to

$$2\mathrm{AI(OH)_3} \longrightarrow \mathrm{AI_2O_3} + 3\mathrm{H_2O(1050kJ/kg)}. \quad (5)$$

The decomposition of aluminum hydroxide can absorb 1050 kJ of heat per kilogram of aluminum hydroxide and act as a coolant in a polymer matrix. The substance that can prevent the burning mechanism of magnesium hydroxide is similar to that of aluminum hydroxide, except that the pyrolysis temperature (>300°C) of magnesium hydroxide is much higher than that of aluminum hydroxide. Therefore, magnesium hydroxide has a great application prospect in polymer materials with high processing temperature, as shown in

$$2\mathrm{Mg(OH)_2} \longrightarrow 2\mathrm{MgO_3} + 2\mathrm{H_2O(1300kJ/kg)}. \quad (6)$$

It should be noted that the substance that can prevent the burning effect of magnesium hydroxide will only appear when the temperature exceeds 400°C. In addition, some studies have shown that the substances that can prevent the burning of polymer materials such as aluminum hydroxide or magnesium hydroxide generally have high requirements for these two fillers, usually more than 50%, which has adverse effects on the mechanical properties of the materials themselves.

3. Selection of Machine Learning Algorithm

There are many algorithms for machine learning, each of which has a certain range of applications. Due to the large size of the data set and small sample size, six machine learning algorithms with small data volumes are selected: GBR, RFR, ETR, ABR, Ridge, and Lasso.

3.1. Gradient Boosting Regressor (GBR). Gradient-enhanced regression tree is a boosting algorithm in ensemble learning, and it is also an improvement of boosting algorithm. Set loss function $L(y, f(x))$, for example, $D = \{(x_1, y_1), (x_2, y_2), \cdots, (x_n, y_n)\}$ of training set. The principle is, first, format the model according to formula (7); calculate the negative gradient information of data $i = 1, 2, \cdots, m$ in the iteration process of $t = 1, 2, \cdots, T$ round according to formula (8). The T-th regression tree is obtained by fitting the regression line with $(x_i, r_{ti})(i = 1, 2, \cdots, m)$, and the corresponding leaf node area is $R_{tj}, j = 1, 2, \cdots, J$, where J is the number of nodes of the regression leaves. The leaf model is updated according to formula (9) and formula (10). When I reaches the maximum iteration times, the regression function is shown in formula (11).

$$f_0(x) = \underbrace{\arg\min}_{c} \sum_{i=1}^{m} L(y_i, c). \tag{7}$$

This formula represents an initial decision tree with only one regression point, C is the minimization constant of the cost function, and $L(y_i, f(x))$ is the marginal function.

$$r_{ti} = -\left[\frac{\partial L(y_i, f(x_i))}{\partial f(x_i)}\right]_{f(x)=f_{t-1}(x)}, \tag{8}$$

$$c_{ti} = \underbrace{\arg\min}_{c} \sum_{x_i \in R_{tj}} L(y_i, f_{t-1}(x_i) + c), \tag{9}$$

$$f_t(x) = f_{t-1}(x) + \sum_{j=1}^{J} c_{tj} I\left(x \in R_{tj}\right), \tag{10}$$

$$f(x) = f_T(x) = f_0(x) + \sum_{t=1}^{T} \sum_{j=1}^{J} c_{tj} I\left(x \in R_{tj}\right). \tag{11}$$

The gradient-enhanced regression tree (GBR) algorithm can deal with continuous and discrete values. When the time for adjusting parameters is relatively short, the prediction accuracy is relatively high. However, due to the dependence among learners, it is difficult for them to train together, and this algorithm is not suitable for large-scale data with sparse attributes.

3.2. Random Forest Regressor (RFR). Random forest algorithm is often used in regression and classification tasks, and the output model is very important, which is applied and efficient in many fields. The principle is to use the bootstrap resampling method to sample the sample data and repeat the above steps until the regression decision for subtree T is formed. They must assume that each tree can grow freely without being cut down and finally, grow into a forest. The average value of all new decision submarks is used as the prediction result of the model.

3.3. Extra Tree Regressor (ETR). Extreme stochastic forest regression is very similar to the stochastic forest model; the difference between them lies in the distribution of nodes in the decision tree. In the process of node splitting, the selected attributes and their associated attribute values are not obtained by searching and comparing, but the attributes are randomly selected, and then the attribute values are randomly selected from the attributes as the basis of node splitting. The advantage of this is that it provides more randomness, prevents overfitting of the model, improves the training speed, but also increases some deviations.

3.4. AdaBoost Regressor (ABR). With the help of AdaBoost, we can achieve an adaptive tree regression algorithm, and we can also use different regression functions to construct learning information, which has high flexibility, a low generalization error rate, and high accuracy. However, the practice of this algorithm is time-consuming, prone to anomalies, and sensitive to noise.

3.5. Ridge Regression (Ridge). In linear models, normalization is usually changed by changing the weight of functions. The ridge regression marginal function is shown in equation (12). Before function regression, the data must be scaled because it is very sensitive to the size of the input attribute.

$$J(\theta) = \mathrm{MSE}(\theta) + \alpha \frac{1}{2} \sum_{i=1}^{n} \theta^2. \tag{12}$$

In the formula, $J(\theta)$ is the marginal function; α is the parameter that controls the ridge regression of the model; and θ is the bias term.

3.6. Lasso Regression (Lasso). Lasso regression is another normalization of the regression model. Like normal form regression, it also adds the normalization coefficient to the cost function, and at the same time, it adds the l_1 norm, which is a part of the square of the l_2 norm. Finally, the cost function is obtained in

$$J(\theta) = \mathrm{MSE}(\theta) + \alpha \sum_{i=1}^{n} |\theta_i|. \tag{13}$$

Table 1: Characteristics of the algorithm.

Type	Algorithm	Running speed	Applicable data type	Is it easy to overfit
Ensemble learning	Gradient lifting regression tree	Slower	Nonlinear data, high-dimensional data, continuous value, discrete value	Not easy
	Stochastic forest regression	Faster	Nonlinear data, high-dimensional data	Not easy
	Extreme random tree regression	Faster	Nonlinear data, high-dimensional data	Not easy
	Adaptive lifting tree regression	Slower	Nonlinear data, high-dimensional data	Not easy
Nonensemble learning	Ridge regression	Slower	Data with collinear data and more features than samples	Not easy
	Lasso regression	Faster	Existence of collinear data	Not easy

In the formula, $J(\theta)$ is the cost control function; α is the relevant parameter of control function regression. Table 1 summarizes the characteristics of the above six algorithms.

3.7. Performance Evaluation Index of Prediction Model. The determination coefficient and square error are used as the indexes for evaluating the model. The determination coefficient shows the fitting degree of the regression function to the predicted value, and its value ranges from 0 to 1. The closer the determination coefficient is to 1, the better the regression fitting is. The square error is also often used to evaluate the efficiency of regression models. The larger the square error, the greater the model error. Equations (14) and (15) represent calculation methods for determining coefficients and square errors, respectively.

$$R^2 = 1 - \frac{\sum_{k=1}^{n}(y_k - x_k)}{\sum_{k=1}^{n}(y_k - \bar{y})}, \tag{14}$$

$$\mathrm{RMSE} = \sqrt{\frac{\sum_{k=1}^{n}(y_k - x_k)^2}{n}}. \tag{15}$$

4. Experimental Analysis

4.1. Establishment of Forecast Model. If the simple random distribution of the original sample data leads to too little modeling data, it is impossible to obtain complete data information, so it is necessary to study effective methods to use the data. If the original sample data is sufficient, a random one-time data set is usually divided into a training set, a verification set, and a test set to practice and test the model. For small data sets, the simple randomization of data leads to too little model data, which makes it impossible to obtain complete data information. Therefore, it is necessary to explore effective methods to make full use of the data.

The basic idea of the cross-validation method is to randomly group the original data, and all the data sets except the test series can be used as a series of exercises and validation so as to obtain more useful information from the limited data, reduce the residual amount to a certain extent, and adjust and improve the generalization of the model. Therefore, the experimental data collected in the modeling process are randomly divided into 10 subsets, and the 10-fold cross-validation method is used to judge the model performance. The principle is shown in Figure 3.

The implementation of machine learning algorithm and cross-validation method is carried out in Jupyter Notebook. All the data is random; most of them are used for training, a small part for validation, and the rest for model performance testing.

To further analyze the algorithm mentioned above, Figure 4 shows the R^2 and RMSE values of six machine learning algorithms and statistical modeling methods (MLR) for predicting the tensile strength of a substance that can prevent burnings after thermal aging. Among them, the RMSE value of the MLR model is the highest and the R^2 value is the lowest, which shows that the prediction accuracy of the six machine learning algorithms is obviously higher than that of the MLR model. It can be seen that for the prediction of the tensile strength of a substance that can prevent burning fabrics after thermal aging.

In order to further analyze the predictive ability of each model, the R^2 and RMSE values of six machine learning algorithms and statistical modeling methods (MLR) for predicting the tensile strength of a substance that can prevent burnings after heating (see Figure 5).

As can be seen from Figure 5, among the six machine learning algorithms, the GBR model has the best prediction ability, followed by the ETR model and the RFR model. Compared with the above three integrated algorithms, Ridge, ABR, and Lasso regression algorithms have relatively poor prediction results. Because data noise is easy to interfere with the algorithm, the abnormal samples of experimental data will be given greater weight in the iterative process, thus affecting the accuracy of the final prediction.

4.2. Comparison of Model Prediction Accuracy under Different Variable Combinations. The combination of G1-G4 variables in Figure 4 is modeled and analyzed using six machine learning and statistical models. Figure 6 shows the modeling of all models R^2 and RMSE after four sets of variables.

Among them, the RMSE value of the MLR model is the highest, and the R^2 value is the lowest, which shows that the MLR model has higher prediction accuracy than the other six machine learning algorithms. The machine learning method has excellent prediction ability, which can greatly improve prediction accuracy.

It can be seen from Figure 6 that when ETR, GBR, and RFR models analyze G1-G3, the prediction accuracy of the models changes little and the difference is minimal. When the model is used to predict, the prediction accuracy of the

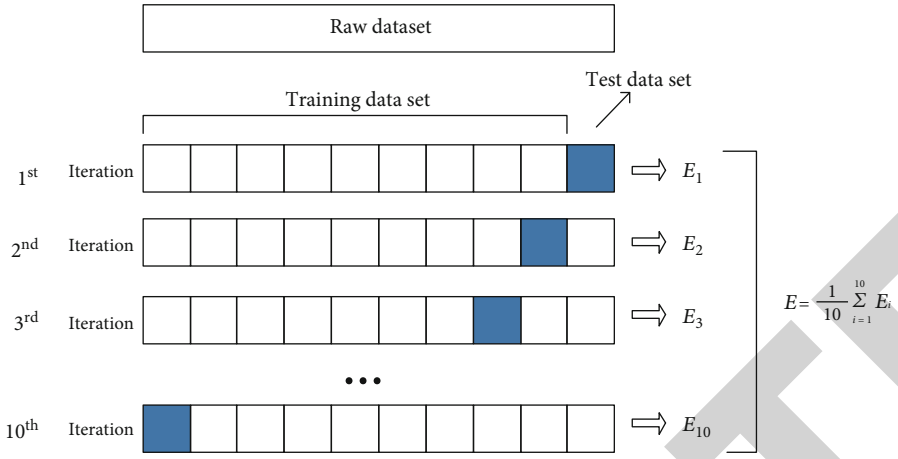

Figure 3: Schematic diagram of 10-fold cross-validation.

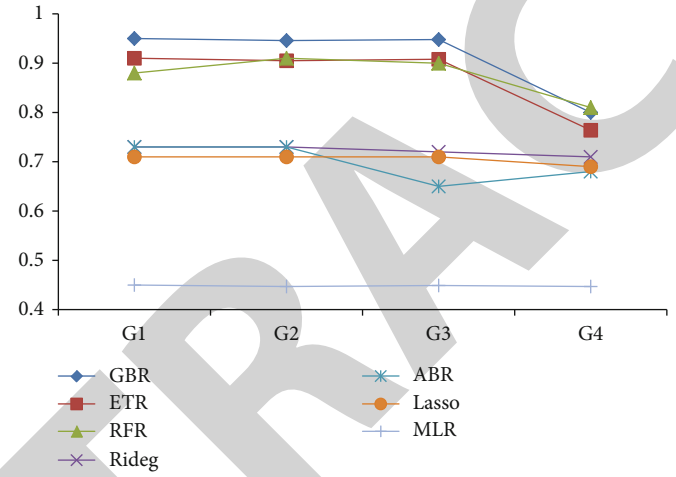

Figure 4: R^2 values predicted by the model for different variable groups.

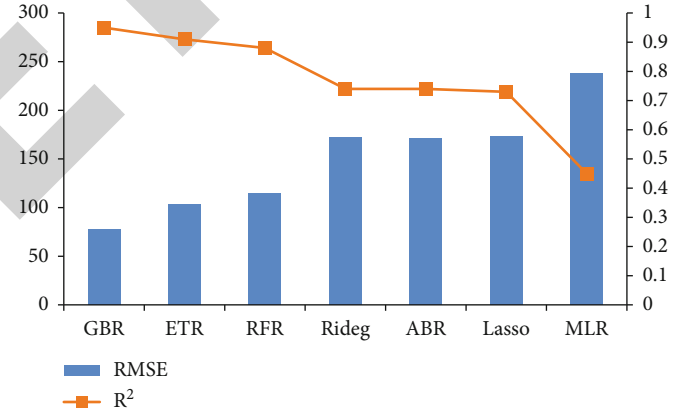

Figure 5: Prediction accuracy of machine learning and statistical model.

three machine learning models decreases significantly, but their prediction accuracy usually has no significant difference (error 5%).

Lasso and Ridge models are traditional linear regression models, and the difference between the two models in predicting four groups of variables is relatively small. This may be because Lasso and Ridge models are ordinary linear models, so they are more likely to remove the weight of the least important attributes. The Lasso regression model can also automatically perform selection tasks and dilute the model thus allowing more functions to have nonzero weights.

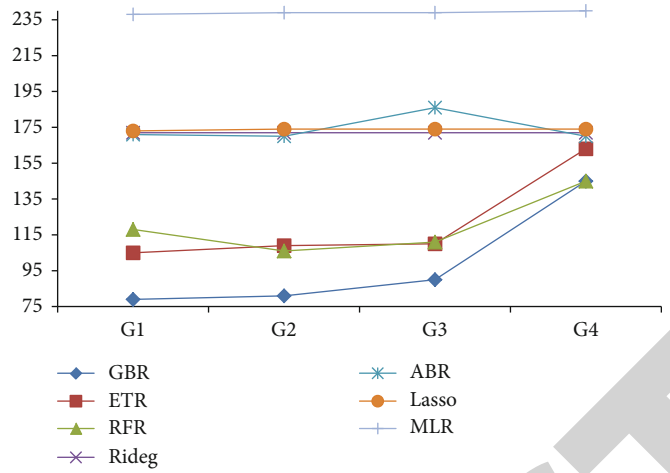

Figure 6: RMSE values of different variable groups predicted by the model.

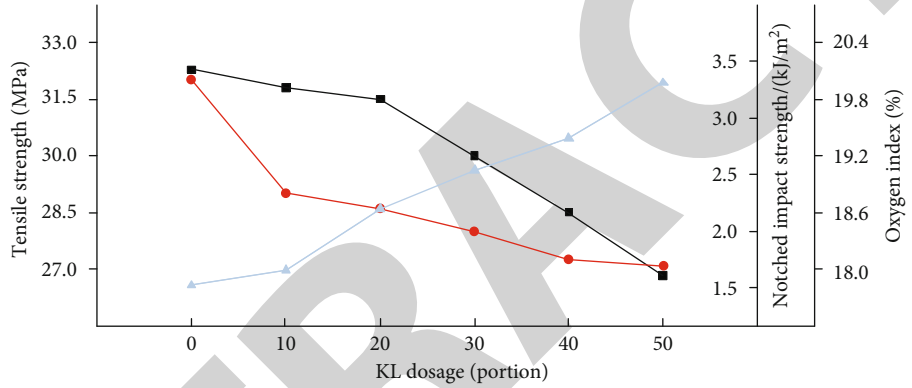

Figure 7: Effect of KL content on flame retardancy of PP/KL composites.

To sum up, compared with statistical models, machine learning shows excellent predictive ability, so it is suitable for predicting the tensile strength of a substance that can prevent burning fabrics after thermal aging. At the same time, it has been found that when using machine learning to model, choosing the appropriate model can get the best prediction results.

4.3. Results and Discussion

4.3.1. Mechanical and a Substance That Can Prevent Burning Properties of PP/KL Composites. Figure 7 shows the effect of KL concentration on the mechanical and a substance that can prevent burning properties of PP/KL composites. As can be seen from Figure 8, with the increase in KL filler content, the molecular material begins to decrease and the oxygen index increases. This is due to the different interfacial adhesion between KL and PP, which destroys the tight intermolecular structure of PP and damages the mechanical properties of the mixture.

Because KL filler reduces the density of substances in the material, hydrated alumina has high endothermic property, forming crystal water $AI_2O_3 \cdot H_2O \longrightarrow AI_2O_3 + H_2O$ between 200 and 300°C, releasing a large amount of water vapor, and at the same time reducing the density of combustible gas, which is oxidized by metals formed in the reaction. It is also a refractory material covering the surface of PP, which improves the refractory ability of PP.

4.3.2. Mechanical and a Substance That Can Prevent Burning Properties of Composite PP/Mg(OH)$_2$. Figure 8 shows the effect of dose $Mg(OH)_2$ on the mechanical and a substance that can prevent the burning properties of PP/$Mg(OH)_2$ composites. It can be seen from the figure that with the increase of $Mg(OH)_2$ filling content, the tensile strength and notched impact strength of the composites decrease, while the oxygen index increases.

The reason for the poor mechanical properties of Mg $(OH)_2$ is the same as the poor miscibility of KL, inorganic filler and PP. The bonding interface is sensitive to stress concentration under load, which is harmful to composites. Magnesium oxide covers the surface of combustible materials to prevent combustible materials from contacting with the outside world, and the released water vapor also reduces the concentration of combustible gases around and affects a substance that can prevent burning.

4.3.3. Mechanical and a Substance That Can Prevent Burning Properties of PP/APP Composites. Figure 9 shows the effect of APP dosage on the mechanical properties and flame

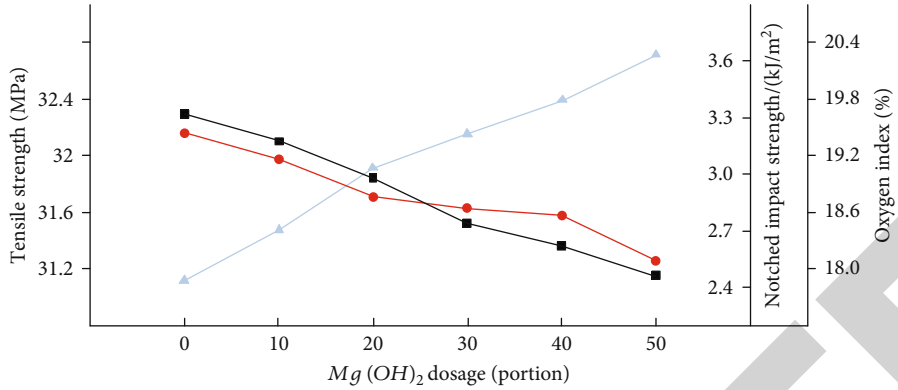

Figure 8: Effect of dosage of $Mg(OH)_2$ on mechanical and a substance that can prevent burning properties of PP/$Mg(OH)_2$ composites.

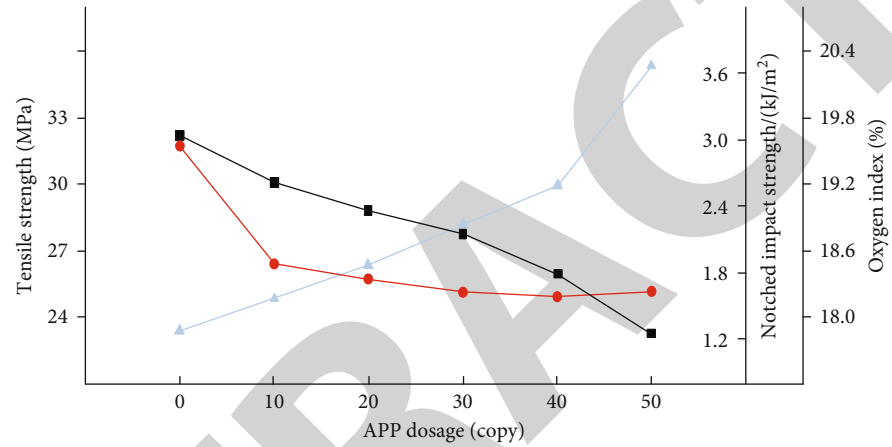

Figure 9: Effect of APP content on mechanical and a substance that can prevent burning properties of PP/APP composites.

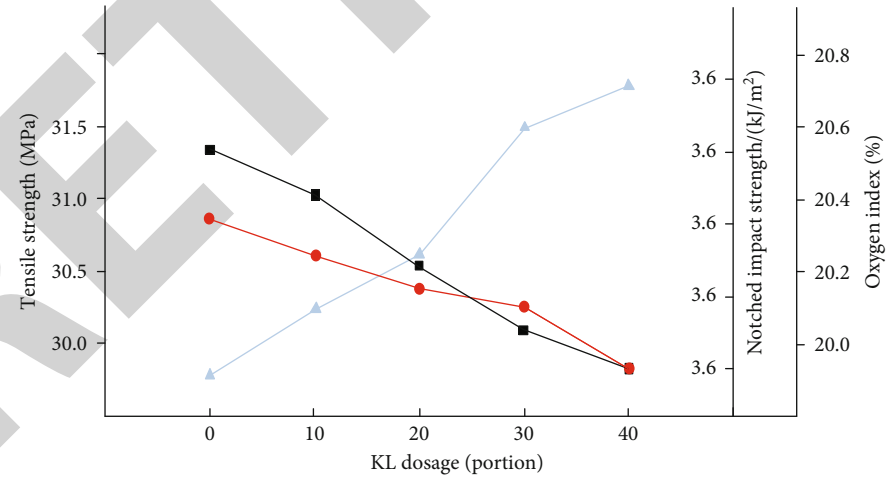

Figure 10: Effect of KL content on mechanical and a substance that can prevent burning properties of PP/$Mg(OH)_2$/KL composites.

retardancy of PP/APP composites. As can be seen from Figure 9, with the increase in APP, the impact strength of the material decreases significantly. During the experiment, the decline degree is greater than that of KL and $Mg(OH)_2$. A free radical substance $PO\cdot$ destroys the chain reaction of free radicals, promotes the carbonization of PP and plays the role of a substance that can prevent burning.

4.3.4. Mechanical and a Substance That Can Prevent Burning Properties of PP/$Mg(OH)_2$/KL Ternary Composites. Through the analysis of the mechanical properties and flame retardancy of the above three kinds of inorganic filler composites, it is found that the effect of PP/$Mg(OH)_2$ composite is better than that of the other two kinds of composites. But their fireproof performance is similar. Therefore, this section

Table 2: Effect of PP-g-MAH on mechanical properties and a substance that can prevent burning properties of PP/inorganic filler ternary composites.

Composite material	Tensile strength/MPA	Notched impact strength/(kJ/m)	Oxygen index/%
PP/$Mg(OH)_2$/KL/PP-g-MAH	32.43 ± 0.13	5.09 ± 0.17	20.2
PP/$Mg(OH)_2$/KL	31.26 ± 0.04	2.65 ± 0.07	20.2

studies the effect of KL dosage on the performance and cost of PP/$Mg(OH)_2$ composites when the dosage of $Mg(OH)_2$ is 40 phr and KL is added.

Figure 10 shows the effect of KL dosage on the mechanical resistance and fire resistance of composites. Because these two substances that can prevent burning are inorganic substance that can prevent burning, PP has different polarities, and the filling of PP destroys the original internal structure and the mechanical properties of materials. In addition, the water vapor released during decomposition has a certain degree of coldness, which can prevent small molecules of flammable gas from escaping and play a substance that can prevent burning. The combination of the two can bring out the best in each other and improve a substance that can prevent burning effect. Finally, the ratio PP/$Mg(OH)_2$/KL (100/40/10) is determined.

4.3.5. Effect of PP-g-MAH on Mechanical and a Substance That Can Prevent Burning Properties of PP/$Mg(OH)_2$/KL Composites. It can be seen from Table 2 that the tensile strength of the composites has increased, but the impact strength has decreased, and the oxygen index has little change. Inorganic fillers are incompatible with PP materials, and inorganic fillers are concentrated together, which leads to poor adhesion at the interface of materials. PP-g-MAH can react with hydroxy acids in materials thus improving impact resistance. When the material is under tension, the surface can absorb the external energy, thus improving the impact resistance of the material. The optimal formula designed for the research project is a 100/40/10/5.

5. Concluding Remarks

At present, the use and procurement of household substances that can prevent burning are still dominated by organic a substances, while the production and supply of inorganic substances that can prevent burning are still relatively scarce, but their development speed and potential have been very high in recent years. Halogen, a substance that can prevent burnings, which is the most commonly used substance that can prevent burnings, is more effective than other substance that can prevent burnings, but they do great harm to the environment and human body. The development and use of additives focus on ecological and environmental protection, so the structure of a substance that can prevent burning products has been studied at home and abroad, and the research and development of high-efficiency environmental protection substances that can prevent burning have been strengthened. Harmless, low-smoke, nontoxic substance that can prevent burning have always been our goal, and the government has made a lot of efforts and achieved remarkable results. With the strengthening of national requirements for fire protection technology, China will have a better opportunity to develop fire protection agents. China should improve its development and innovation ability and promote the development of the fire protection industry in the direction of environmental protection, harmlessness, high efficiency, and practicality.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

Acknowledgments

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Retraction

Retracted: Display and Analysis of Virtual 3D Technology in Interior Design

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] L. Sen and L. Yang, "Display and Analysis of Virtual 3D Technology in Interior Design," *Journal of Sensors*, vol. 2023, Article ID 2231483, 10 pages, 2023.

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Volume 2023, Article ID 2231483, 10 pages
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Research Article

Display and Analysis of Virtual 3D Technology in Interior Design

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People are not satisfied with the two-dimensional technology, and three-dimensional virtual technology gradually enters every aspect of people's daily life: medical treatment, education, social interaction, vision, and so on. Virtual 3D technology brings a lot of convenience to people's lives and plays a core role in indoor scene design and layout. It enables users to see their own virtual indoor furniture and vegetation layout in advance and select and modify their own needs. We put forward several characteristics of indoor furniture selection and placement, such as no space restriction, interactivity and fault tolerance, and advanced display. We construct the basic algorithm of image transformation registration detection and finally optimize the basic algorithm with three different deep learning algorithm models, and get that the convolution layer neural network algorithm is superior to the other two models not only in the selection and placement of virtual furniture but also in the layout design of virtual vegetation landscape. Finally, for image defect detection, we compare the time cost of three models, which further shows that the convolution layer combined with image transformation technology model is fast and efficient.

1. Introduction

Virtual 3D technology is more and more widely used in our daily life, especially in architecture design, VR games, and humanities education. In different academic research, digital 3D technology in humanities education scene, community, and cognitive differences in several aspects carried out a good application value [1]. In addition to several 3D technology applications introduced above, virtual technology also plays a core value application in the development of games, combining campus real scene with virtual technology, so that students can feel the campus environment on the Internet [2]. In orthodontic treatment, facing the patient's ideal face, doctors should carry out 3D face detection on the patient and combine 3D imaging with modeling technology to give the patient an ideal treatment plan [3]. Many cultural relics in history have been damaged to varying degrees. Using 3D technology to restore cultural relics enables our future generations to reunderstand the exquisite technology and wisdom of ancestors at that time [4]. The Black Ding Bowl in Inner Mongolia was restored, and the restored appearance was obtained by virtual reconstruction through 3D technology, and prosthetic materials were used for long-term preservation of cultural relics [5]. For animation design of ancient buildings in film and television works, it is necessary to set up the mutual unity of ancient buildings and characters according to the specific characters and environment at that time [6]. A series of operations for detection and resection of intracranial tumors need the support of three-dimensional technology, which can have a clear understanding of the size and location of tumors and improve the success rate of surgery [7]. In archaeological research, integrating 3D technology into archaeology can promote students' deep understanding of archaeology and full 3D reasoning, which runs through the whole archaeological process [8]. In the marine ecosystem, coral reef is an important part of maintaining the ecosystem. The structural restoration of damaged coral reef by 3D technology shows the expansibility of 3D model [9]. For the complex causes of dentists, such as adjacent supernumerary teeth, pulp tumor, and trauma, 3D virtual images are obtained by computed tomography (CT) technology, and replicas are generated by LCD-based mask stereolithography 3D printing technology [10]. For the practice teaching of congenital

heart disease, 3D printing and heart model combined with PBL technology are selected for teaching [11]. In the humanitarian social environment, for Africa and other countries with poor medical environment, 3D technology and telemedicine are used to provide medical assistance to patients under virtual technology. Our common 3D imaging is different from looking directly at images and videos with our ordinary eyes. For 2D imaging, the influence of 3D on human vision is convex instead of planar imaging [12, 13]. In the course of fashion design, students are taught to print 3D fashion products, make a prototype of 3D accessories, use computer-aided design to increase students' understanding of computer-aided design methods [14], use CAD and 3D technology to manufacture high-precision mechanical devices, build a low-temperature goniometer, and measure samples from different angles [15]. However, 3D printing technology also has an unbreakable difficulty, although it already has the advantages of high-precision printing to show smooth objects and fast printing speed [16]. The drug was prepared by 3D printing technology, and the coaxial scaffold with controllable tissue was used for long-term stable drug release [17]. In cosmetic surgery, 3D design is also applied to maxillofacial bone reconstruction surgery, which can be combined with anatomy, and 3D implantation increases the perfection of this kind of surgery [18]. In rhinoplasty, the simulated 3D image is converted into the operation plan of the operating room in a quantitative way, which is helpful to quantitatively translate the patient target in dorsal reduction rhinoplasty to the operating room and patients in the form of preoperative markers [19]. In the digital education space, the engineering thinking mode is used to formulate the principles and support directions of student research activity tutors in three-dimensional modeling [20]. The use of 3D printing technology in medicine is aimed at determining whether medical students are willing to use this technology to obtain accurate anatomical models to help them learn [21]. 3D printing is an increasingly feasible method, which can be used to customize the design and manufacture of assistive technologies. The evaluation of assistive technologies to be 3D printed should include information about individual activities, routines, skills, abilities, and preferences [22]. Ceramics can be replicated and mapped by 3D printing technology [23]. Children's dentition, jaw and facial growth, and development are disordered. The nasolabial angle and facial convex angle in the study group are significantly larger than those in the control group, and the difference is statistically significant [24]. Papers on multimodal data using spectral imaging and 3D technology in remote sensing, including new sensors, developing machine learning technology for data analysis, and the application of these technologies in various geospatial applications [25].

2. Virtual Scene Design

2.1. Basic Framework. Virtual design of indoor scenes is a three-tier network architecture with server as the core, the expression layer is the user of virtual design scheme, and the architecture logic layer includes indoor virtual layout design, indoor virtual furniture design, and indoor virtual vegetation landscape layout. The data access layer is MySQL technology. The basic architecture of indoor virtual scene design and layout using VRML/X3D technology is shown in Figure 1.

2.2. Design and Layout Process of Indoor Scenes. The virtual design of indoor scene needs to collect the customer's demand information firstly and draw up the general layout and modeling design of the scene according to the customer's demand. First, the basic configuration of each indoor scene is carried out, and then the specific integrated design of each area is carried out. The complete virtual design steps of indoor scene are as follows:

(1) Collect and sort out the customer's demand and feasibility analysis data, as well as the data needed to build indoor scenes

(2) Establish the basic layout model of indoor apartment, which includes ground model, wall model, door and window model, and furniture and vegetation landscape layout design for indoor scenes in each area

(3) Display the data of each basic model with three-dimensional graphics and see the preliminary building model

(4) The main network and network homepage will be constructed and connected with virtual files

(5) Finally, the complete virtual design result of indoor landscape is obtained

2.3. Features of Virtual Furniture. Furniture is a necessary entity in a building house, and it takes time and effort for entities to enter the interior for on-site design. Therefore, the existence of the Internet has led to virtual furniture display, so that consumers can choose their favorite furniture without leaving home. The characteristics of virtual furniture display are as follows:

(1) Not Limited by Space. Virtual furniture in the indoor display can let consumers no matter where at what time can see the furniture entity in the indoor virtual display, which breaks the actual distance. The display of virtual furniture on the network can also show the scene to multiple customers at the same time, which can also improve the efficiency of customers' furniture selection, and the merchants can also obtain higher profits and achieve a win-win situation for both parties.

(2) Interactivity and Fault Tolerance. Virtual furniture can be selected according to their own preferences and placed indoors, and they will not interfere with other users' personalized design while choosing on the network. Users can also modify and adjust in real time in the virtual scene, which has great fault tolerance in furniture design. This makes furniture display more innovative and dynamic.

(3) The Characteristics of Advanced Display. The display of virtual furniture in indoor scenes can appear in the customer's field of vision in advance, and even if the furniture has not been produced, it can be purchased by customers

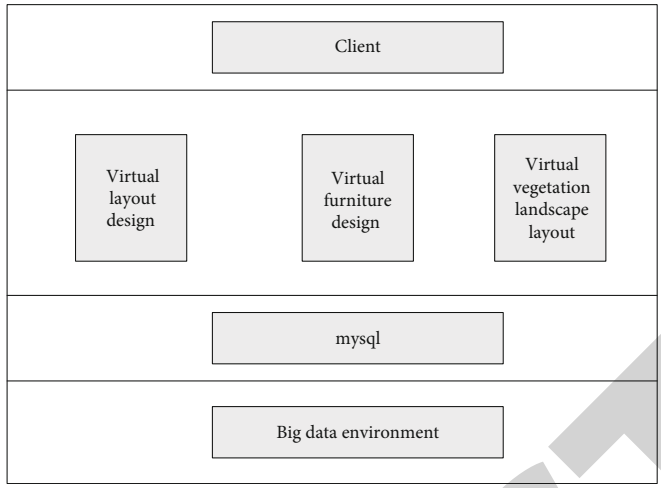

Figure 1: Basic architecture of virtual scene design.

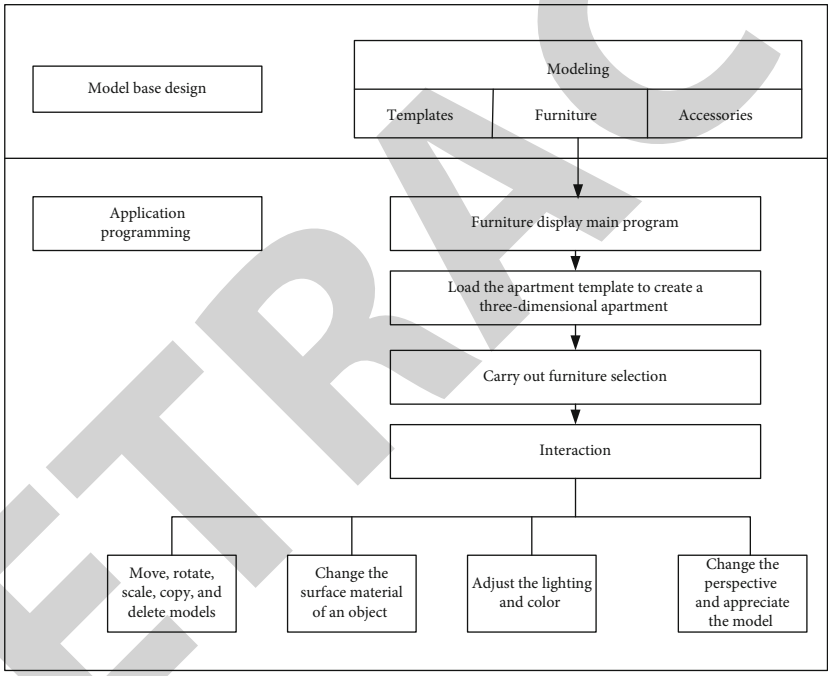

Figure 2: Framework of virtual furniture display system based on 3D modeling.

in advance. In this way, producers can quickly know which furniture customers like, and then mass-produce, so that they can clearly know the needs of customers.

The system framework of software model base design and program design for virtual furniture display is shown in Figure 2.

(4) Energy Conservation and Environmental Protection. Furniture for physical display will use materials that are not environmentally friendly, such as large spray-painted portraits and foam boards. Virtual furniture can reduce cost and environmental pollution and use virtual technology to help customers choose furniture, save energy, and achieve green environmental protection. VMware virtualization solutions can reduce millions of tons of carbon dioxide emissions in the air, not only directly swing furniture for customers to choose but also greatly reduce labor costs.

The indoor display renderings of three different apartment types after being designed by virtual technology are shown in Figures 3–5:

3. Image Processing Algorithms

3.1. Image Transformation. The indoor spatial position is expressed by coordinate transformation.

$$\left(x', y'\right) = g(x, y). \tag{1}$$

Figure 3: Virtual design unit 1.

Figure 4: Virtual designer 2.

The expression that transforms the two-dimensional coordinates of the drawing of an indoor scene to (x', y') through a rigid body at a certain point.

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos\varphi \pm \sin\varphi \\ \sin\varphi \mp \cos\varphi \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} t_x \\ t_y \end{bmatrix}. \tag{2}$$

An expression that affines the two-dimensional coordinates of the drawing of an indoor scene to (x', y') at a certain point.

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} t_x \\ t_y \end{bmatrix}. \tag{3}$$

Figure 5: Virtual design unit 3.

When the solid model is projected, all points on any straight line on the image before and after transformation are still on a straight line after transformation, but parallel lines cannot continue to keep parallel relationship after transformation. The transformation formula of projection transformation is

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}. \tag{4}$$

3.2. Image Gray Interpolation. In the image, each coordinate value is discrete, after the image transformation cannot proceed to the next step of processing. Therefore, the image gray difference algorithm is perfectly used to solve this problem. We use the common bilinear interpolation method to solve the problem, and the principle of this algorithm is shown in Figure 6.

Calculate the gray values of E and F.

$$\begin{aligned} f(E) &= \left(x' - i\right)[f(B) - f(A)] + f(A), \\ f(F) &= \left(x' - i\right)[f(D) - f(C)] + f(C). \end{aligned} \tag{5}$$

Calculate the gray value of the fixed point.

$$f(x, y) = (y - j)[f(F) - f(E)] + f(E). \tag{6}$$

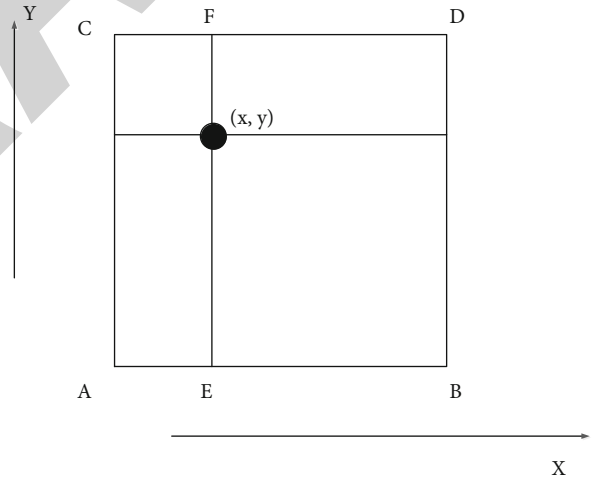

Figure 6: Schematic diagram of image gray interpolation algorithm.

3.3. Image Registration Algorithm. In a virtual space scene, two coordinate points use intuitive similarity measure to measure the similarity expression.

$$\begin{aligned} D(i, j) &= \sum_{m=1}^{M} \sum_{n=1}^{m} \left[S^{i,j}(m, n)\right] - T(m, n)]^2, (i, j \in (1, N - M + 1)) \\ &= \sum_{m=1}^{M} \sum_{n=1}^{m} \left[S^{i,j}(m, n)\right]^2 - 2 \sum_{m=1}^{M} \sum_{n=1}^{M} S^{i,j}(m, n) * T(m, n) \\ &\quad + \sum_{m=1}^{M} \sum_{n=1}^{M} [T(m, n)]^2. \end{aligned} \tag{7}$$

In order to prevent the local gray intensity from affecting the registration results, the normalized cross-correlation coefficient can be used to register the similarity measure.

$$R(i.j) = \frac{\sum_{m=1}^{M}\sum_{n=1}^{m}\left[S^{i,j}(m,n) - \bar{S}\right]^2 \times \left[T(m,n) - \bar{T}\right]}{\sqrt{\sum_{m=1}^{M}\sum_{n=1}^{m}\left[S^{i,j}(m,n) - \bar{S}\right]^2}\sqrt{\sum_{m=1}^{M}\sum_{n=1}^{m}\left[T(m,n) - \bar{T}\right]^2}}. \tag{8}$$

Principle of Nontext Matching: in the standard image, two ROI regions are selected, one is T1 region with central coordinates (x_1, y_1) and the other is T2 region with central coordinates (x_2, y_2).

The angle between the connecting line of the center points of the two regions and the horizontal line is

$$\theta = \text{arc}tg\frac{y_2 - y_1}{x_2 - x_1}. \tag{9}$$

After normalized cross-correlation single template matching, the center coordinate point is recorded, and the included angle between the connecting line of the center points of the two regions and the horizontal line is as follows:

$$\theta' = \text{arc}tg\frac{y_2{}' - y_1{}'}{x_2{}' - x_1{}'}. \tag{10}$$

Image Rotation Angle:

$$\alpha = \theta' - \theta. \tag{11}$$

If the coordinates of a point on the image $f(x, y)$ to be measured are (x, y), and the coordinates after theta angle rotation transformation with (x_0, y_0) as the rotation center become (x', y'), there are

$$\begin{aligned} x' &= (x - x_0)\cos\theta + (y - y_0)\sin\theta + x_0 = x^*\cos\theta + y^*\sin\theta + Dx, \\ y' &= (y - y_0)\cos\theta + (x - x_0)\sin\theta + y_0 = y^*\cos\theta - x^*\sin\theta + Dy. \end{aligned} \tag{12}$$

Among them

$$\begin{aligned} Dx &= -x_0\cos\theta - y_0\sin\theta + x_0, \\ Dy &= -x_0\sin\theta - y_0\cos\theta + y_0. \end{aligned} \tag{13}$$

The registration relationship between the image to be tested $f(x, y)$ and the template image $g(x, y)$ can be modified as follows:

$$\begin{aligned} x' &= x^*\cos\theta + y^*\sin\theta + Dx + \Delta x, \\ y' &= y^*\cos\theta - x^*\sin\theta + Dy + \Delta y. \end{aligned} \tag{14}$$

3.4. Image Rotation Angle Detection. The edge pixels of indoor scene are extracted by binarization, and the detected edge images are processed by binarization. If the gray image is $f(x, y)$, its average gray scale is

$$T = \frac{\sum_{i=0}^{m-1}\sum_{j=0}^{n-1} f(i,j)}{m \times n}. \tag{15}$$

The gray value of each pixel in the image is compared with the average gray value, and two sets larger than T and smaller than T are calculated, respectively. The formula is as follows:

$$\begin{aligned} T1 &= \frac{\sum_{i=0}^{T}\text{in}_i}{\sum_{i=0}^{T} n_i}, \\ T2 &= \frac{\sum_{i=T+1}\text{in}_i}{\sum_{i=T+1} n_i}. \end{aligned} \tag{16}$$

After Hough domain peak detection, the limit T is preset.

$$T = \lambda\text{max}\text{A}(\rho, \theta). \tag{17}$$

If the geometrical deformation between the values of f_1 and f_2 is an offset $(\Delta x, \Delta y)$, the expression is as follows:

$$f_2(x, y) = f_1(x - \Delta x, y - \Delta y). \tag{18}$$

The transformation results in

$$F_2(w_x, w_y) = e^{-j\left(\Delta x w_x + \Delta y w_y\right)} F_1(w_x, w_y). \tag{19}$$

If there is an offset in the phase spectrum $(\Delta x, \Delta y)$ Direct correlation deviation $e^{j(\Delta x w_x + \Delta y w_y)}$, i.e., if there is an offset $(\Delta x, \Delta y)$ on the phase spectrum, it is directly related to the deviation $e^{j(\Delta x w_x + \Delta y w_y)}$, that is

$$e^{j\left(\Delta x w_x + \Delta y w_y\right)} = \frac{F_1(w_x, w_y) F_2^*(w_x, w_y)}{\left|F_1(w_x, w_y) F_2^*(w_x, w_y)\right|}, \tag{20}$$

4. Experiment

4.1. Simulation Experiment. The pure text image with clothes size of 512*512 is transformed into an experimental image by transforming parameters $(\theta, \Delta x, \Delta y)$ for many times, and then the image registration experiment is carried out, and the simulation experimental results are given as shown in Table 1. The rigid transformation model is used in this paper, and the transformation parameters are $(\theta, \Delta x, \Delta y)$. The commonly used methods of image transformation model are

Rigid Body Transformation Expression:

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta & t_x \\ \sin\theta & \cos\theta & t_y \\ 0 & 0 & 1 \end{bmatrix}. \tag{21}$$

Table 1: Experimental results of image registration.

Serial number	Actual parameters	Experimental results	Time cost (s)
1	(4.5, 1, 1)	(4.5, 1, 1)	0.723
2	(4.5, 3, 3)	(4.5, 3, 2)	0.741
3	(4.5, 3, 2)	(4.5, 2, 2)	0.752
4	(-3, 3, 5)	(-3, 3, 4)	0.786
5	(5, 3, 1)	(5.2, 3, 1)	0.759
6	(2.5 ,5, 6)	(3, 5, 6)	0.781
7	(-2.5, 2, 5)	(-3, 3, 5)	0.757
8	(-1, 4, 5)	(-1, 5, 5)	0.765

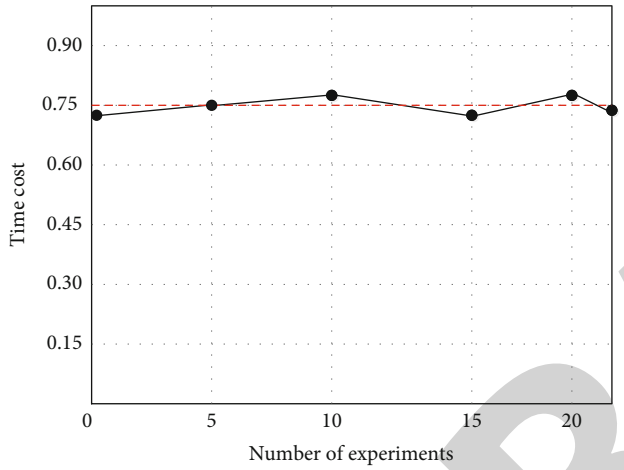

Figure 7: Statistical chart of registration time.

Affine Transformation Expression:

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} a_1 & a_2 & t_x \\ a_3 & a_4 & t_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}. \quad (22)$$

Projection Transformation Expression:

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} a_1 & a_2 & a_3 \\ a_4 & a_5 & a_6 \\ a_7 & a_8 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}. \quad (23)$$

Nonlinear Transformation Expression:

$$\left(x', y'\right) = F(x, y). \quad (24)$$

Through the above table, the registration results of image transformation are analyzed and counted, and the average time and cost of image transformation are obtained from the results of many experiments as shown in Figure 7.

The red horizontal line in the figure represents the average value of the time cost, which is about 0.75 s, and is obtained by averaging the time results of multiple image transformations. The average level of time response of the model is 0.75 s, so the average level of model performance can be known, and the average level of model response ability can also be described.

Table 2: Furniture selection and placement based on convolution neural network and image transformation technology.

Furniture selection and placement	Accuracy	Recall	F1	Roc
Sofa	98.87%	76.87%	76.86%	81.25%
Coffee table	97.86%	77.54%	73.76%	82.35%
Bed	97.54%	76.34%	76.52%	83.21%
TV refrigerator	96.87%	77.28%	77.21%	81.61%
Cabinet	95.89%	75.81%	75.37%	82.57%
Bookcase	96.72%	77.29%	75.92%	81.78%

Table 3: Furniture selection and placement by DBN combined with image transformation technology.

Furniture selection and placement	Accuracy	Recall	F1	Roc
Sofa	96.57%	64.57%	66.66%	71.28%
Coffee table	97.84%	66.52%	63.56%	73.15%
Bed	96.43%	61.24%	64.72%	75.31%
TV refrigerator	95.17%	67.26%	67.26%	72.22%
Cabinet	95.22%	65.43%	65.45%	73.43%
Bookcase	95.12%	63.28%	65.52%	74.31%

Table 4: Furniture selection and placement based on stack self-coding network and image transformation technology.

Furniture selection and placement	Accuracy	Recall	F1	Roc
Sofa	92.51%	60.67%	62.66%	70.28%
Coffee table	93.83%	62.54%	61.56%	69.85%
Bed	92.44%	63.26%	60.72%	72.45%
TV refrigerator	93.22%	62.35%	62.26%	71.28%
Cabinet	92.24%	61.47%	63.47%	72.82%
Bookcase	91.19%	62.25%	64.63%	73.36%

4.2. Model Comparison. In order to further improve the image transformation technology, we combine the depth learning model to optimize the technology and improve the registration accuracy of image changes. Let users get the layout design under the virtual scene conveniently and clearly and compare the model performance of indoor furniture selection and placement and vegetation landscape layout by image transformation technology under different deep learning.

When using virtual technology to select and place indoor furniture, the performance of image transformation technology combined with three different deep learning algorithms is compared, as shown in Tables 2–4.

Model performance of convolution neural network combined with image transformation technology for virtual selection and placement of furniture is shown in Figure 8.

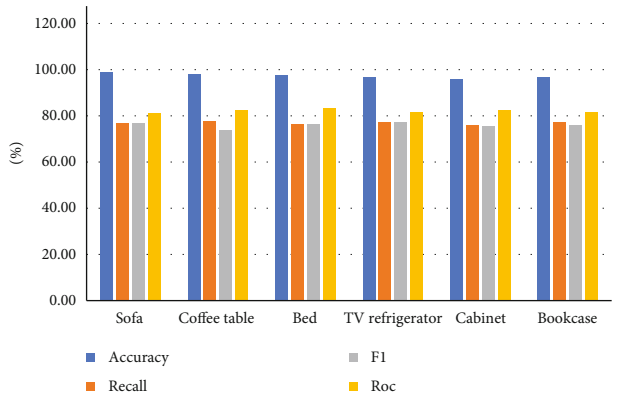

Figure 8: Performance comparison of convolution neural network combined with image transformation technology.

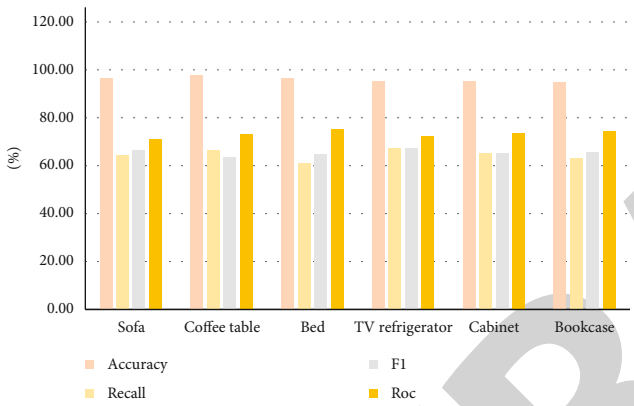

Figure 9: Performance comparison of DBN combined with image transformation technology.

Model performance of DBN combined with image transformation technology for virtual selection and placement of furniture is shown in Figure 9.

Model performance of stack self-coding network combined with image transformation technology for virtual selection and placement of furniture is shown in Figure 10.

When using virtual technology for vegetation landscape layout in different indoor areas, the performance of image transformation technology combined with three different deep learning algorithms is compared, as shown in Tables 5–7.

Convolution neural network combined with image transformation technology for performance comparison of vegetation landscape layout model in different indoor areas is shown in Figure 11.

DBN combined with image transformation technology for vegetation landscape layout model performance comparison in different indoor areas is shown in Figure 12.

Stack self-coding network combined with image transformation technology for performance comparison of vegetation landscape layout model in different indoor areas is shown in Figure 13.

4.3. Contrast Experiment. The three types of algorithms under deep learning combine image transformation technology to detect and compare the image defects of indoor virtual scene layout display, carry out many experiments on virtual graphics, and count the time cost of detecting defect errors, as shown in Figure 14.

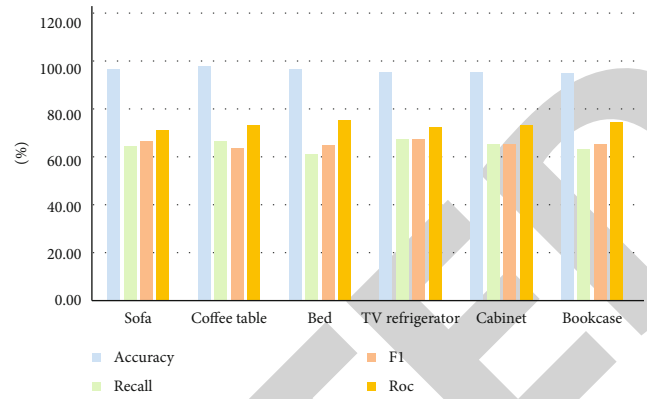

Figure 10: Performance comparison of stack self-coding network combined with image transformation technology.

Table 5: Convolution neural network combined with image transformation technology for vegetation landscape layout in different areas.

Indoor area	Accuracy	Recall	F1	Roc
Living room	97.89%	82.81%	78.88%	83.24%
Balcony	98.56%	87.54%	78.69%	84.38%
Bedroom	98.69%	86.36%	77.82%	83.36%
Restaurant	97.88%	87.28%	77.59%	82.64%
Kitchen	98.92%	85.82%	76.65%	81.58%
Toilet	97.76%	87.23%	77.98%	82.48%

Table 6: Layout of vegetation landscape in different indoor areas by DBN combined with image transformation technology.

Indoor area	Accuracy	Recall	F1	Roc
Living room	92.83%	76.82%	75.82%	76.24%
Balcony	93.52%	77.56%	76.64%	75.31%
Bedroom	94.65%	76.32%	74.82%	78.25%
Restaurant	94.83%	77.23%	75.54%	77.25%
Kitchen	95.32%	75.19%	74.68%	77.38%
Toilet	95.56%	77.24%	74.28%	73.46%

Table 7: Layout of vegetation landscape in different indoor areas by stack self-coding network combined with image transformation technology.

Indoor area	Accuracy	Recall	F1	Roc
Living room	92.53%	72.85%	72.81%	72.25%
Balcony	93.56%	74.54%	72.64%	71.35%
Bedroom	93.68%	73.31%	73.43%	72.72%
Restaurant	94.82%	73.25%	73.27%	72.29%
Kitchen	95.16%	74.29%	72.61%	71.46%
Toilet	95.27%	73.25%	73.49%	72.58%

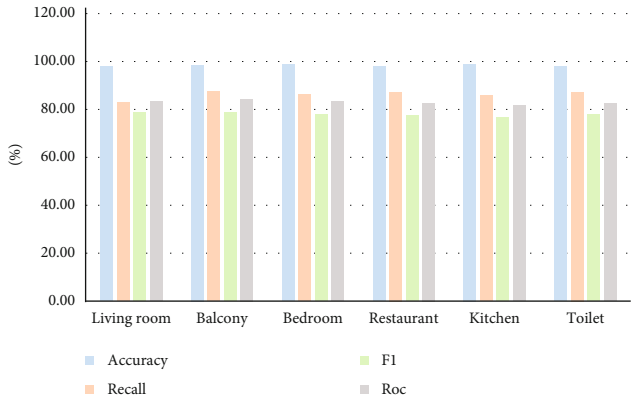

Figure 11: Performance comparison of convolution neural network combined with image transformation technology.

Figure 12: Performance comparison of DBN combined with image transformation technology.

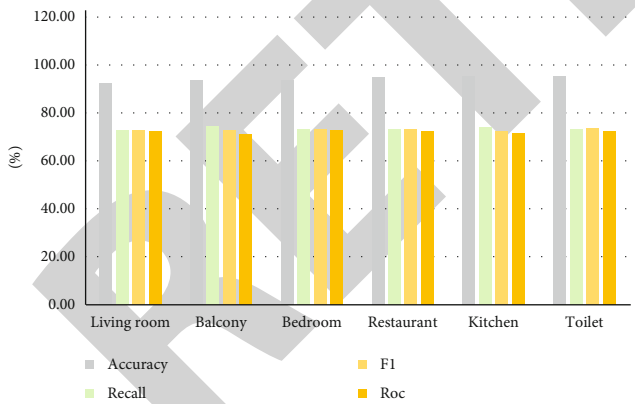

Figure 13: Performance comparison of stack self-coding network combined with image transformation technology.

The biggest time cost is the stack self-coding network combined with image transformation technology model. The training steps of the stack self-coding network model are divided into two steps: the first step is to design the self-coding network to initialize parameters for prelearning, and the second step is to design a classifier, and then use the classifier to fine-tune the model using the initialization

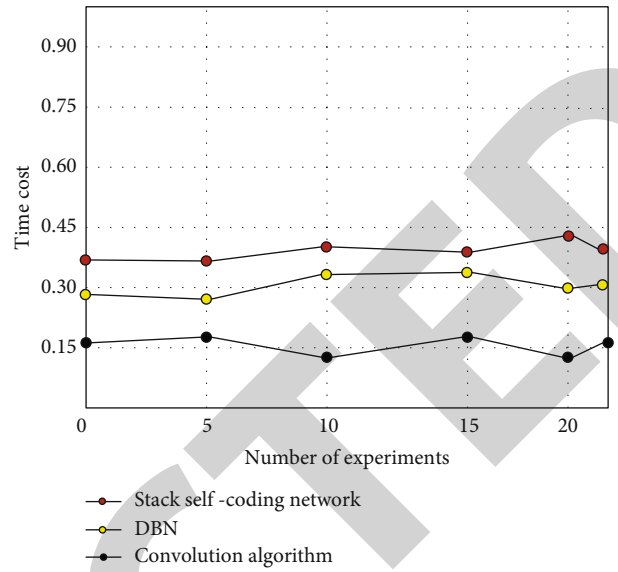

Figure 14: Comparison of time and cost of three optimized models.

parameters learned in the first step. Self-coding network of each layer in the learning process is

$$X_l = \sigma_l^a(W_l^a \times X_{l-1} + b_l^a),$$
$$X_{l-1} = \sigma_l^s(W_l^s \times X_l + b_l^s). \quad (25)$$

The convolution algorithm with the best performance is combined with the image transformation model: the sparse connection of the convolutional neural network has a regularization effect, which improves the stability and generalization ability of the network structure and avoids over-fitting, while the sparse connection reduces the total amount of weight parameters, which is conducive to the rapid learning of the neural network and reduces the memory overhead during calculation.

5. Conclusion

People's demand for 3D technology far exceeds that of 2D technology, and the application value of 3D technology is also higher. In order to analyze the virtual technology, the indoor scene is designed and analyzed. By comparing and analyzing three typical depth learning algorithms combined with image transformation technology, we get the following conclusions:

(1) In the simulation experiment, we get that the average time cost of traditional plain text image detection is about 0.75, which is much higher than that of the optimized model

(2) 3D technology realizes the best visual experience of man-machine interaction through real three-dimensional scenes and enhances realism and interactivity

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Retraction

Retracted: Hardware Optimization and System Design of Elliptic Curve Encryption Algorithm Based on FPGA

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] J. Li and W. Gao, "Hardware Optimization and System Design of Elliptic Curve Encryption Algorithm Based on FPGA," *Journal of Sensors*, vol. 2022, Article ID 9074524, 12 pages, 2022.

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Research Article

Hardware Optimization and System Design of Elliptic Curve Encryption Algorithm Based on FPGA

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Since entering the era of big data, the degree of information sharing is getting higher and higher; the information exchange is becoming more and more convenient, but at the same time, personal information is also easy to be exposed to the network environment, if it is used by criminals to lead to information leakage, and then bring certain risks. Therefore, it is in the information age and do a good job of network information security and confidentiality. At present, the security and secrecy of network information are mainly realized by cryptography. Public key cryptography can encrypt information and ensure the security of information transmission, so it is widely used in the contemporary society. At present, elliptic curve encryption is highly respected in the research field of public key cryptosystem. Elliptic curve encryption is divided into two main points, multiplication and inversion, respectively. Through the comparison of these two algorithms, it can be found that there are several choices if the main research objective is to save time, and the Euclidean extension method is mainly discussed in this paper. In other words, more efficient algorithms are used in the hardware implementation process, and a variety of algorithms can be used instead of a single curve algorithm. In this process, we can find the special features of upper level operation and bottom level finite operation. The upper level operation is KP operation, while the bottom level operation is fast calculation of four kinds of K in finite field operation, and finally realize FPGA algorithm. With the help of Quartus ii developed by predecessors, the upper and lower operations of elliptic curve are carried out using VHDL language. Combined ANXIX9.62 in the elliptic curve of each module to test, so as to ensure the accuracy of the data, reduces the error. According to the test results, the designed chip can efficiently complete the elliptic curve encryption system in the whole process. And the average KP operation time can reach 15.15 ms at 20 MHz frequency. At the same time, the chip can complete the operation on ECC public key with any variable curve in F domain less than 256. Therefore, this chip is a high-speed elliptic curve cryptographic chip with optional system parameters. Based on this, this article on the elliptic curve encryption algorithm based on FPGA hardware implementation of system design, from the view of mathematical study analysis, was carried out on the elliptic curve cryptosystem, according to the above two big difficulty, namely, the polynomial of GF(2), the finite field multiplication, and inversion; there will be a detailed studies of discussion, through software comparison to find the differences between different software, especially the software implementation performance level. In addition, it will also focus on the design of elliptic curve algorithm PGA, so as to explore the solution of the algorithm hardware.

1. Introduction

With the continuous improvement of the degree of social information, the ways of people's life, production, and communication have changed dramatically. Computer network has become an indispensable information communication medium in life and study and is an irreplaceable information product for people at present. Openness is both the advantage and disadvantage of computer network, especially when it is violated by network security [1, 2]. This disadvantage is more obvious. At present, it can take the solution measures that personnel management measures cannot fundamentally solve the problem; it is difficult to prevent the computer network security to be violated again, but the emergence of

password technology can solve this problem, so in the password technology used in computer network security is more and more important. This is shown in Figure 1.

It was not until 1976 that network secure communication public key cryptography [3] was formally paid attention to by people. After that, more and more implementation schemes of public key cryptography [4] became applicable to various professional fields, and the technology became more and more mature. At present, it can be roughly divided into three categories: (1) the decomposition of large numbers as the idea; (2) take the discrete number pairs in finite domain as the idea; (3) take the discrete number pairs of elliptic curves as the idea. The above classification is mainly based on the mathematical problems of the nature of their schemes, and these schemes have certain security and realizability. It is worth noting that in the above classification, the scheme based on the discrete number pairs of elliptic curves is a kind of cryptosystem. According to the latest academic research, it is concluded that the security of elliptic curve cryptography data transmission with different bit lengths can keep the same basically. For example, there is no significant difference between the security of 160 bit and 1024 bit keys. It can be understood that the key length is 210 bits, and the security is equivalent to the key length of 2048 bits. By contrast, it shows that elliptic curve cryptography is far superior to other public key cryptosystems. People are becoming aware of the commercial and military value behind elliptic curves. Although the 13th Five-Year Plan adjusted the national development of the important task, information network security as one of the key tasks, but the research on elliptic curve discrete logarithm public key cryptography still needs to be developed.

2. The Research Background

Although the emergence of cryptography [4] has a history of thousands of years, during which some people have taken it as a research direction and produced practical applications, the real development of cryptography as a discipline was actually in the middle of the 20th century. Nowadays, cryptography is not only limited to the original political, diplomatic, and military fields but has been developed more widely, becoming an interdisciplinary subject including computer, electronic communication, mathematics, microelectronics, and other technologies. Its function is far more than encrypting information and even can avoid the loss of information data, attack and theft, and so on. Figure 2 shows the first proposed secure communication information model. In the Figure 2, the plaintext M refers to the sender sending, and then C is used for encryption to ensure the security of data transmission. The security factor of the whole system is not related to the encryption system and the confidentiality principle of the algorithm, only depends on the key itself. In other words, even if the encryption and decryption algorithms are exposed, if you want to restore the ciphertext to the plaintext, you must know the composition of the key. In addition, for the concepts of encryption algorithm and decryption algorithm, in fact, they are essentially the parameters used by the algorithm, which have similarities but also differences. According to the characteristics of the key, the algorithm of the password is different. According to the characteristics, it can be divided into two cryptographic algorithms: symmetric key algorithm and public key algorithm. As shown in Figure 2.

If analyzed from the perspective of encryption, the private key cipher can be refined into sequence cipher and block cipher. The principle of sequential cryptography is that after the seed key is transmitted to the sender and receiver through a secure channel, the key stream generator generates the key stream needed for encryption and decryption. But encryption and decryption are a simple modular operation. As for the mathematical model of block cipher, the plaintext is converted into a sequence of numbers by encoding technology and divided into N groups of a certain length, and each group has M bytes. Each group is transformed into an output digit sequence of equal length under the control of the key.

If the same key is used in the process of encryption and decryption, it can be called symmetric encryption system [5]. Therefore, the sender and receiver must select and preserve the shared key, and both parties must have full trust to each other, believe that the other party will not disclose the key, so as to ensure the security and integrity of the information data. Asymmetric cryptographic algorithm can be understood as public key cryptographic algorithm or two-key cryptographic algorithm. According to the classification of algorithms, encryption key and decryption key are two different concepts. In addition, the encryption key has the characteristics of openness, can get rid of time and region restrictions, and can be disclosed, but the decryption key is different and needs to ensure its privacy. Because of the public nature of the encryption key itself, it is also called public key. The decryption key is also known as the private secret key. Among them, the advantage of the private key cryptography algorithm is that the operation process is simple, and the complexity is not high. The disadvantage is that the distribution and management of the key are relatively complex, and it will be slightly difficult to apply in the large-scale network. In addition, it cannot verify the integrity of the sender's identity, so it cannot be applied to digital signature. In contrast, public key cryptography perfectly handles these two problems, and more solutions can be explored. It can be seen that the public key cryptography algorithm has higher application value than the private key cryptography algorithm, but it is a pity that the public key cryptography algorithm has great space complexity and time complexity. Compared with conventional algorithms, the computational cost of public-key cryptography algorithm is larger. For example, the computational cost of DES algorithm is several powers higher. Based on this feature, the application scope of public key is mainly concentrated in the fields with low workload and less data transmission, such as digital signature. This is shown in Figure 3.

In general, the antiattack strength [6] of an algorithm can reflect the security performance of an encryption algorithm, which is an important index to measure. ECC has a strong advantage over RSA, DSA, and other public key systems in this respect. RSA, for example, is one of the most

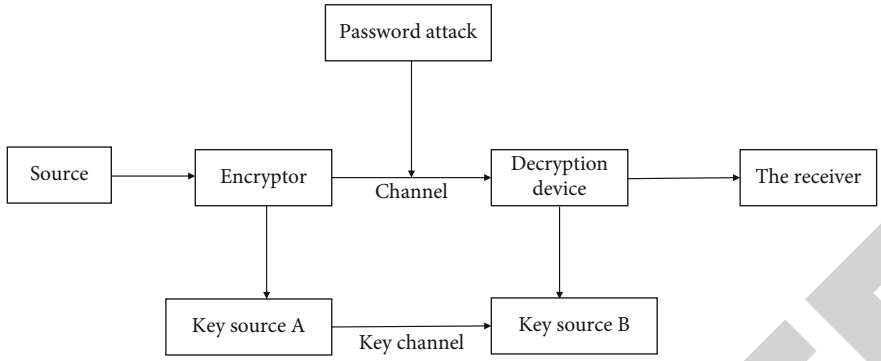

Figure 1: Cryptosystem model.

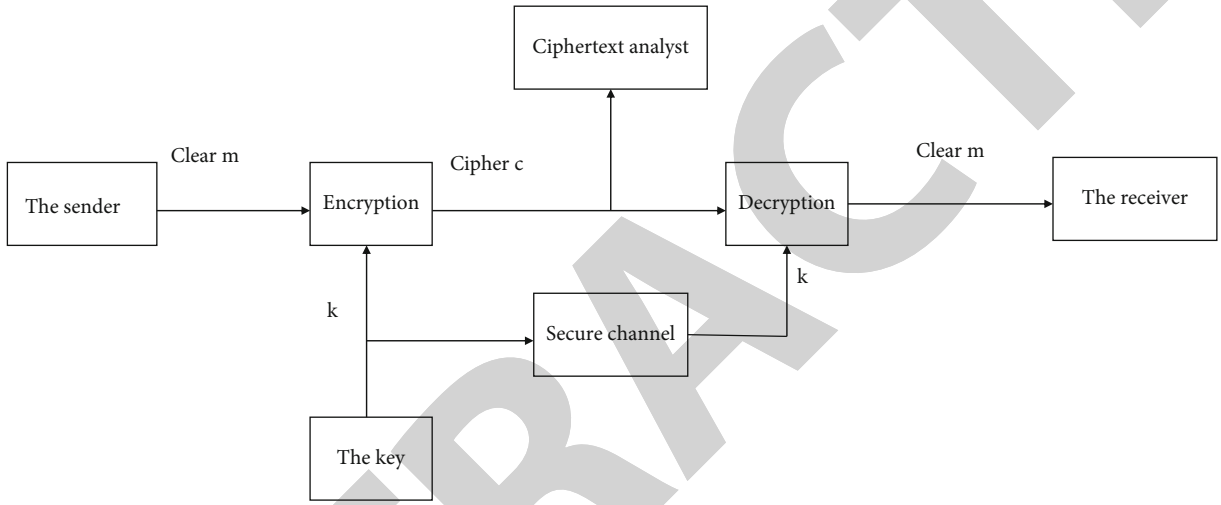

Figure 2: Shannon's secure communication model.

widely used public key systems because of its simple mathematical principles and applications. Subsequently, due to the continuous optimization and modification of the positive factorization scheme and the continuous development of the running speed of the computer, the large number of RSA encryption and decryption security requirements are much larger than before, and the natural need to increase the length of the key to ensure the security of RSA. Generally speaking, only the key length [7] above 1024 bits is secure enough. Unfortunately, because the key length is inversely proportional to the decryption speed, the longer the key length is, the slower the decryption speed is, and the hardware is difficult to realize, which undoubtedly brings great difficulties to the RSA application and greatly affects the RSA application. At this time, the advantages of elliptic curve are highlighted; under the same security strength, the key length of RSA and DSA is much longer than that of ECC, which proves the advantages of ECC. At the same time, elliptic curve encryption can achieve lower bandwidth and smaller storage space to deal with the same problem. Bandwidth and storage space are critical for applications where processor performance, network bandwidth, and hardware storage are limited. For example, web server. Key length of ECC and RSA/DSA is under the same security conditions.

3. Materials and Methods

3.1. Principle of Elliptic Curve Encryption (ECC)

3.1.1. Elliptic Curve. The elliptic curve equation referred to in everyday life often refers to the Wirtschaftsler equation. This equation is expressed mathematically as a series of formulas that satisfy specific conditions within a defined plane curve. In a given number field, it is studied which number couples can be points on an elliptic curve in that field of action. Also, this field of action can be a field of rational numbers (infinite field) or a finite field (finite number of elements in this field). An elliptic curve is a curve symmetric about the x coordinate. In addition to the points of the curve on the coordinate system, the elliptic curve defines an additional point (at infinity), denoted as 0. That is, the elliptic curve is composed of a number of points that meet certain conditions.

About Weierstrass equation:

$$Y^2Z + a_1XYZ + a_3YZ^2 = X^3 + a_2X^2Z + a_4XZ^2 + a_6Z^3, a_1 \in K. \quad (1)$$

An algebraic curve with genus 1 defined in a K-field (for a given field) can be determined by a cubic equation. The specific formula is as above. If and only if the discriminant

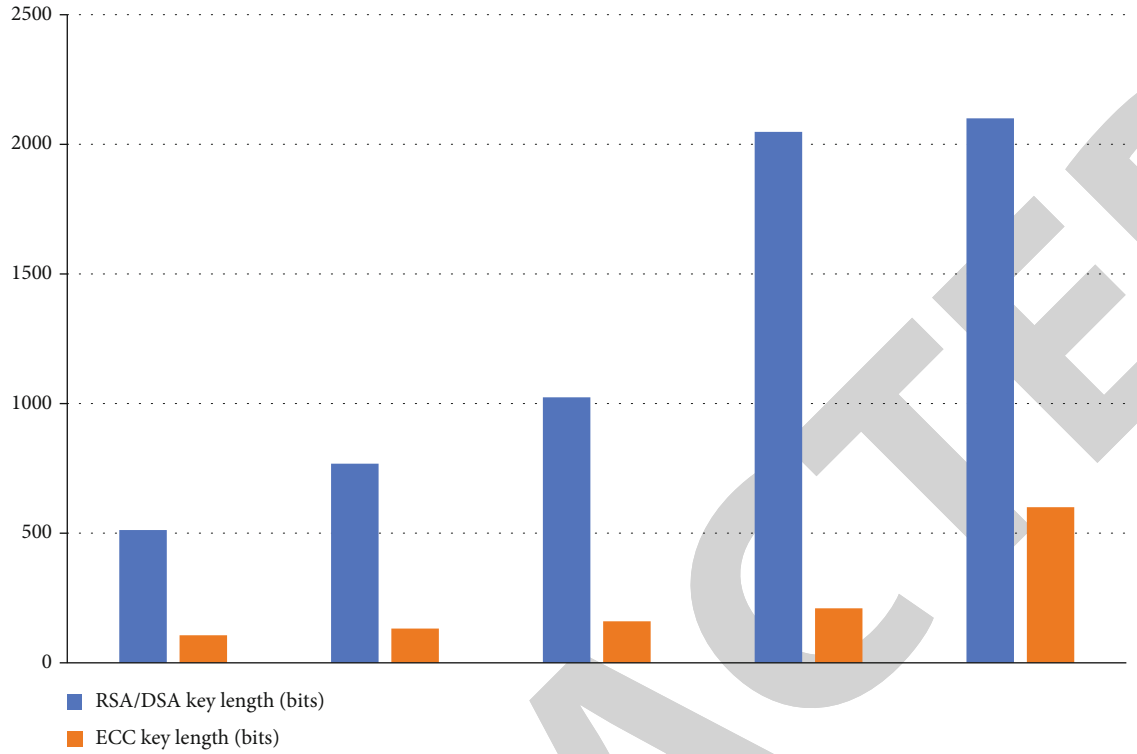

Figure 3: Key length diagram of ECC and RSA/DSA with the same security strength.

of the equation is not equal to 0, it is a nonsingular curve, and the others are singular curves. The group of elliptic curves is defined as the group of operations on the domain K. The elliptic curve has a point $P^2(\bar{K})$ O (0, 1, 0) in the projective plane, which is called the point of infinity. There are two kinds of point operations in elliptic curves, namely, point plus operations and double point operations. In general, finite field operations and point operations on elliptic curves are the basis of ECC. Encryption systems GF(p) for elliptic GF(2^n) curves in finite fields and over finite fields.

The group of elliptic curves in GF (p) in the prime field [8]:

Let P be a prime number less than 3 and $A4a^3 + 27b^2 \neq 0$ and $B \in \mathrm{GF}(p)$ satisfy, then A and B will determine that an elliptic curve is the set of points formed by Equation (2) on GF (p):

$$y^2 = x^3 + ax + b. \tag{2}$$

In the formula of elliptic curve, the definition of adding this symbol is that three points on the elliptic curve are on the same line, and their sum is O. This rule is also known as the rule of "tangent string [9]."

From (2) according to Haas theorem (where the point set of GF (p) is denoted by #GF (p)):

$$p + 1 - 2\sqrt{p} \leq \#\mathrm{GF}(p) \leq p + 1 + 2\sqrt{p}. \tag{3}$$

3.1.2. Comparison between ECC and RSA. The security of RSA system is still high; this is because the large integer factorization is very difficult, and it means that the operation process is more complex, so in today's mathematics is still difficult to attack the problem, and there is no relevant personage also gets the corresponding solution, so relatively speaking, the safety factor of the system is higher and is widely used in the encryption system, to better protect confidential resources. In addition to the security aspects of the RSA system, the operating principle and operation of the system are simple. Even nonprofessionals can quickly master the RSA system after training. However, with the advent of the era of data, as well as the in-depth research of science and technology, the work efficiency of large integer decomposition has been rapidly improved. The large integer decomposition work can be decomposed by multiple computers at the same time, and the decomposition speed is greatly accelerated, which affects the confidentiality of the system. Therefore, the encryption security of RSA system is faced with certain challenges. In order to ensure the system security and prevent data leakage, the number of key bits is increasing, which greatly reduces the efficiency of cracking speed and makes the hardware implementation more difficult. In this case, the RSA system is difficult to adapt to some industries, such as e-commerce. If the system is continued to be used, the application scope of the system will become more narrow, which is not conducive to its business expansion. In comparison, elliptic curve encryption method has more application advantages than RSA, as shown in Figure 4.

In elliptic curve encryption system, there are three main aspects of hierarchy, including encryption layer, group operation layer, and arithmetic operation layer. Firstly, the encryption system parameters of elliptic curve

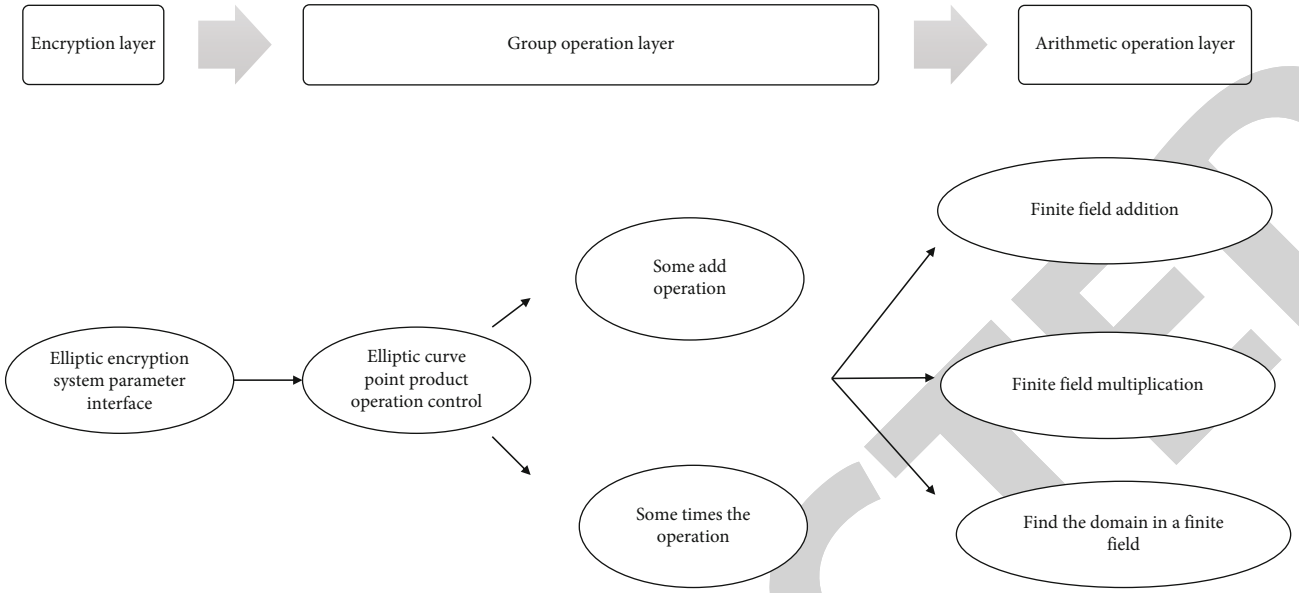

Figure 4: Hierarchy of elliptic curve encryption system.

in encryption layer are obtained by the point multiplication operation of elliptic curve in group operation level. Then the arithmetic operation level will be divided into finite field addition and finite field multiplication and finite field domain.

(i) Higher security performance. The security to run and use is significantly higher than that of RSA systems. The security performance of the encryption algorithm is positively proportional to the attack strength of the algorithm. The higher the attack strength is, the higher the security performance of the encryption algorithm is. For example, the public key of 160 bit ECC is equal to the public key of 1024 bit RSA and DSA and has the same security strength. 210 bit ECC has the same safety strength as 2048 bit RSA and DSA. The comparison of the security performance of symmetric cipher [10], ECC, and RSA/DSA is shown in Figure 5

(ii) The calculation is simplified, and the amount of calculation is smaller. RSA can improve the processing speed of encryption and signature verification by selecting relatively small ones, which has the advantage of competing with ECC. However, if the design of private key processing, that is, decryption and signature, it does not have any advantage, because ECC has higher processing efficiency

Computation is directly related to computation overhead. The key length of the public and private keys depends on the computational overhead. For example, the ECC160 bit key length, 1024 bit RSA key length, and DSA key length correspond to different security indices, because the corresponding systems and keys are different.

The computation overhead of ECC and RSA systems can be compared and studied in Figure 6, where Q is the 160 bit key, and the corresponding data table is the number of operation units. However, due to the particularity of the specific situation, the data have certain errors. As shown in Figure 6.

(iii) The storage space is greatly reduced, and the key occupies a smaller proportion of the memory, which can produce more advantages in the encryption algorithm. The storage space is defined as follows. The plaintext of different encryption algorithms forms the plaintext space of the corresponding algorithm, and all the ciphertext after encryption forms the ciphertext space. Different key spaces are formed according to the length of the key. In particular, the recommended number of rounds of encryption will vary with the length of the key. The key length, key pair, and system parameters have special bits. The corresponding parameters of the three systems are shown in Figure 7. It can be seen that the system parameters used by ECC are shorter than those required by the other two systems. As shown in Figure 7

(iv) Significant changes in bandwidth requirements, especially for short message applications. In the decryption state of long messages, the bandwidth requirement of ECC is the same and does not change significantly, but in the application of short messages, the bandwidth requirement of ECC is significantly reduced. At present, the public key encryption system is more widely used in short messages, for example, the digital signature [10] used in the bank for some business, which is realized by key transfer. Because of the low bandwidth requirement

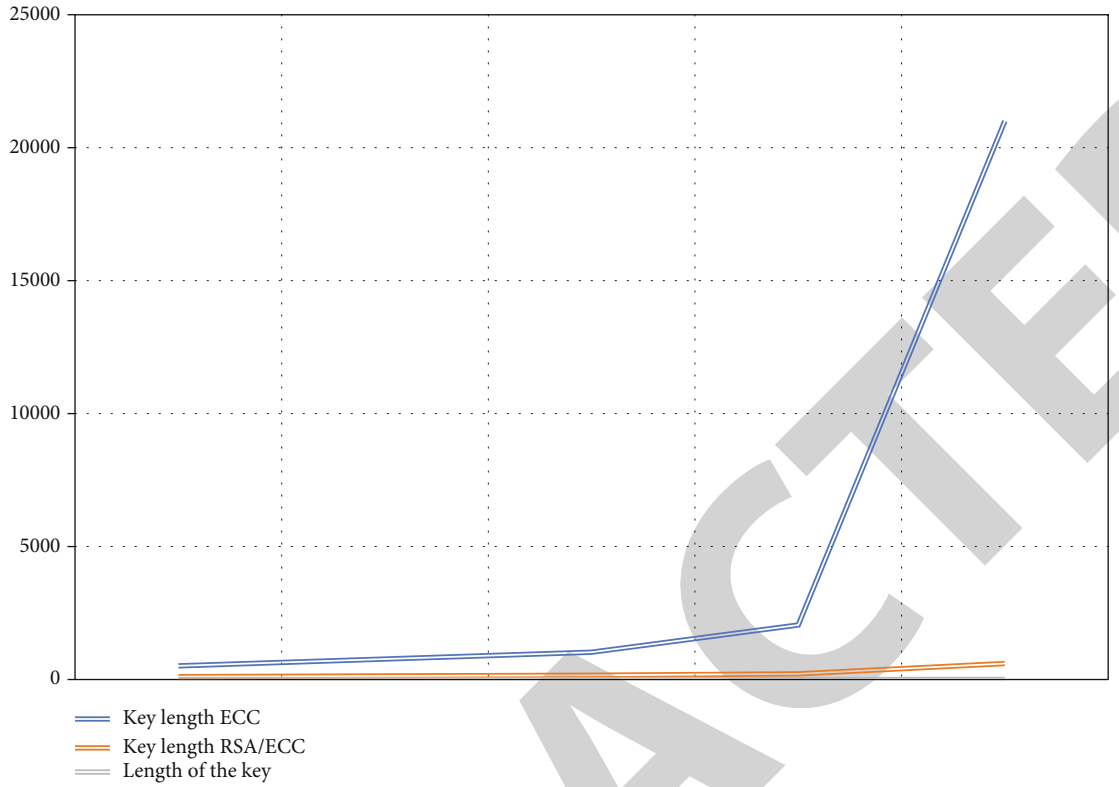

Figure 5: Comparison of safety performance.

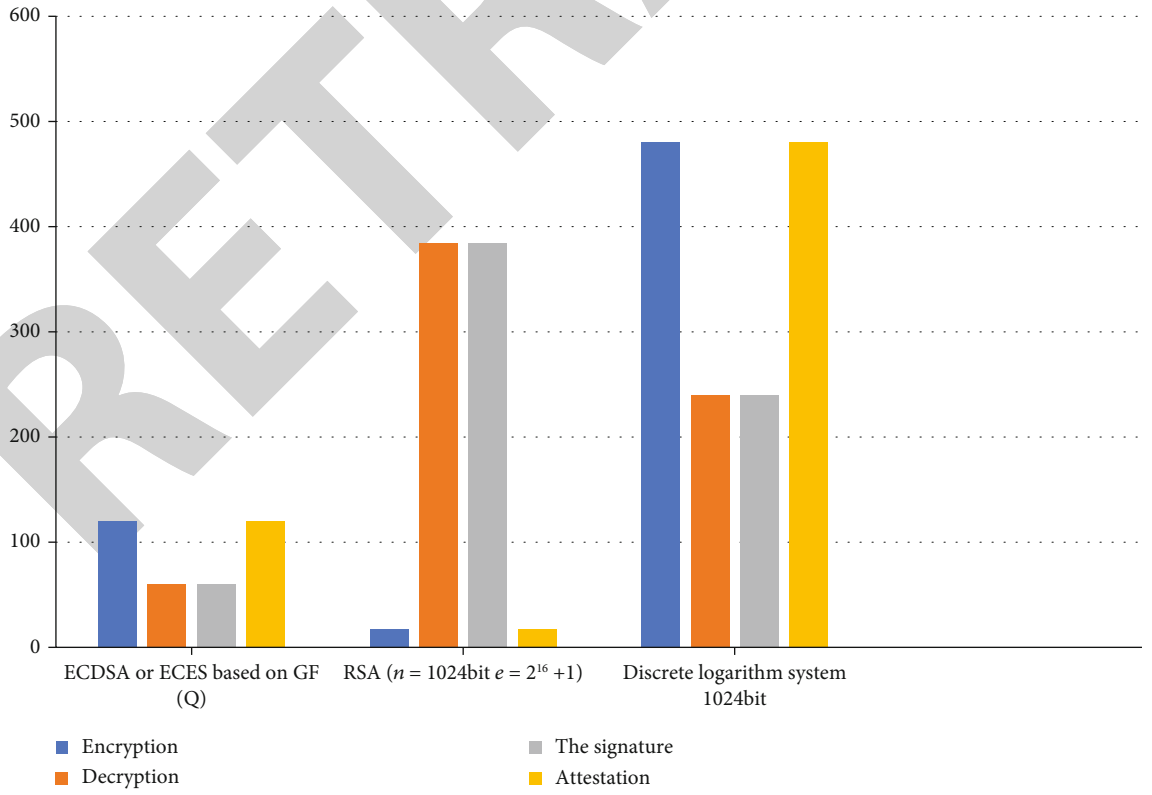

Figure 6: Comparison of processing speed.

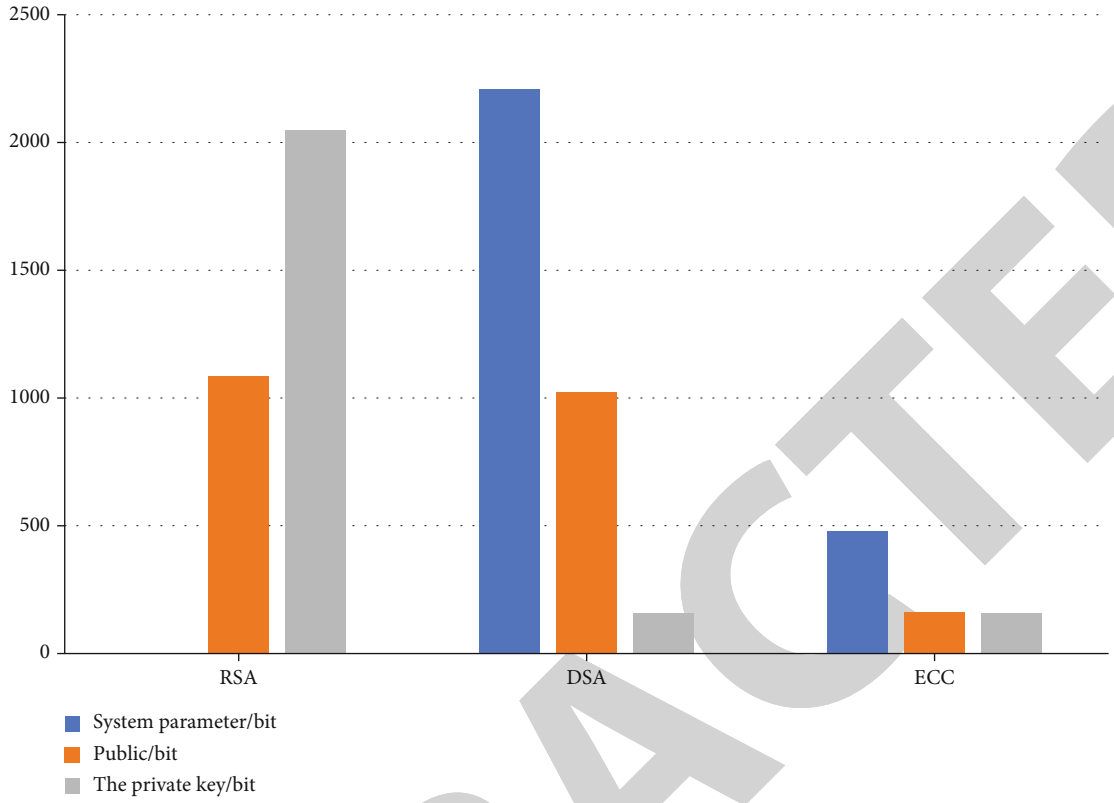

Figure 7: Comparison of system parameters and key pair length.

of public key encryption system, ECC has a great development space in wireless network applications. Based on the above characteristics, elliptic decurving cryptography has received high attention and praise. Nowadays, the cryptographic circles even think that RSA will be replaced in the market position, and the makers of SET (Secure E-lectronic Transactions) protocol have regarded it as the next generation of public key cryptographic algorithm of SET protocol. For specific comparison, it is assumed that the message to be signed is 2 000 bit long, and the message to be encrypted is 100 bit long. The details of the length analysis of the signed and encrypted messages in several cases are shown in Figure 8

As can be seen from Figure 8, when short messages are converted by ECC, the bandwidth demand can be optimized to the best extent. In addition, the point compression technology of ECC also has the advantages of saving the space and bandwidth of storing key certificates. Through the above analysis and comparison, it can be seen that ECC has more obvious application advantages, mainly reflected in high-strength encryption, efficient execution [11], and key. Therefore, compared with other public key encryption systems, ECC can achieve relatively high security with less overhead and delay, that is to say, it has higher cost performance and can be widely used in computing power, such as IC cards and some computer networks.

3.2. Application System Verification. After the hardware implementation of elliptic encryption, the corresponding verification work is still needed to further verify the accuracy of the experimental results. Therefore, by constructing serial port encryption experiment [12] version, the success of elliptic encryption system hardware test is further confirmed.

4. Results and Discussion

The research content of this chapter is mainly carried out around the system simulation test and operation. The research work is centered on the system test and extended in two directions, namely, functional test and performance test. In the function test, the function module is tested, the operation effect of the function module is detected, and the function requirement standard of the module is accurately judged. The problem of high memory usage is studied in performance test. At the same time, the corresponding solution is discussed through the analysis of test results. Finally, through the whole system running effect test, it shows that the system has a strong stability.

For FPGA hardware implementation, the elliptic curve encryption control system module [13] is very important in the system, which is the key to the operation of the whole system. That is, when ready is true, the system contacts information and reads data for storage. When PP = R and PQ = R are entered into the operation, the module will select the appropriate data source corresponding selector for cyclic

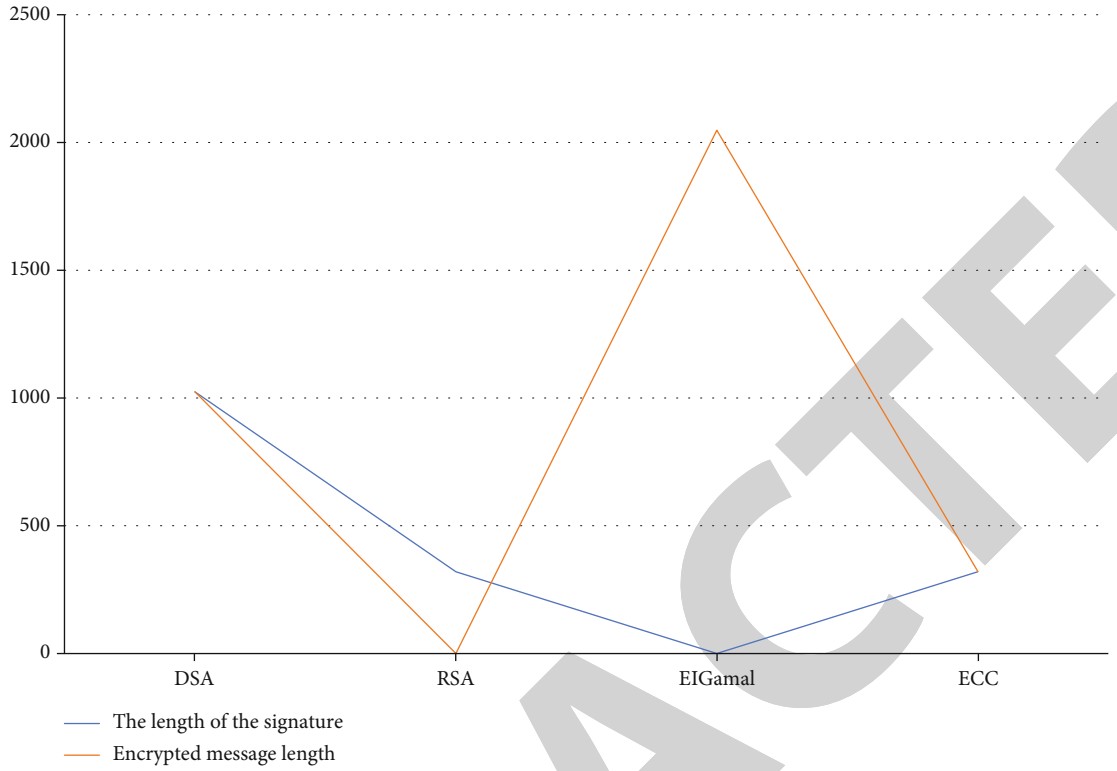

Figure 8: Length analysis of signed and encrypted messages.

control, and after obtaining the operation result, it will output through Qut_ signal. The subsequent control will always enter the control link, which will be controlled according to PP = *R* module [14] and PQ = *R* module [15] combined with specific instructions and provide data flow. In the end, to calculate the add operation on the elliptic curve, they need to combine the above two modules and the county in addition and multiplication, and the addition of points on elliptic curve and speed of system performance is a direct connection; if subsequent output data flow is not accurate, there is a big error that will affect the operation rate and cannot reach high operation speed. In short, different memory modules correspond to different instructions, so the results of subsequent operations are also different.

Cryptographic algorithm is a mathematical function that needs to be applied in the process of encryption and decryption. In terms of current research and application, there are many cryptographic algorithms used, such as block cipher and public key cipher. The function of the cryptographic algorithm is actually to serve the transmission of information and ensure the security of information. It will screen the received information and then encrypt the accepted content into ciphertext through the algorithm. For example, if I want to send information with the help of a social media device, so you can use the password algorithm encryption processing, the content of the information in this process can produce relatively after another a cipher text, also is the key, then the information of the receiver will be through another cipher, use the key to restore the content. In this way, information can be transmitted securely. Among the cryptographic algorithms established on the basis of elliptic curve, there are three common cryptographic algorithms: key pair generation algorithm, signature algorithm, and encryption algorithm. Firstly, the elliptic curve version of digital signature ECDSA includes signature operation and verification operation. Let A and B be two communicating parties on a common communication channel, where they have the same elliptic curve parameters (Fq, E, n, h, and G). E is the elliptic curve, G is the base point of Eq. N is the order of the elliptic curve. The encryption process is explained by referring to elliptic curve parameters [16], and H is the cofactor. If A uses a random number dA as its private key, the public key $PA = dA \cdot G$ is calculated. The private key and public key are the key pair of A. As mentioned above, public keys are publicly available. Assume that A signs to B, and the signature and verification process will be as follows.

The first part of signature is input the private key dA, and the signature message M contains the authentication information of A and output the signature data (r, s). After the operation, the signature of this message is sent to B. Part 2 verification: input public key PA (r, s) and message M; then the validity judgment result of the signature is output. The second public key encryption algorithm assumes that two communication parties A and B have the same elliptic curve parameters on the common communication channel. B takes a random number dB as the private key and calculates $PB = dB \cdot G$. That is, the private key and public key are the key pair of A. The public key in the pair is public. ECES A sends a packet M to B. The process for encrypting and

decrypting the packet is as follows. First, the ECES encryption algorithm is used. The unencrypted ECES and public key PB are input, and the encrypted data C is output. Second, B runs ECES decryption algorithm, and input the obtained encrypted data C and private key dB. Packet M was outputted or decrypted. The last procedure is the key pair generation algorithm; the two algorithms mentioned above are digital signature verification algorithm and encryption and decryption algorithm, that is, a pair of public and private keys. So you have the key that generates the algorithm, and the service that generates the algorithm that generates the key. The specific process of the key pair generation algorithm is as follows. Input a random number d, which ranges from 1 to n-1 and input an elliptic curve base point G. output D and Q. D and Q are obtained by the algorithm $Q = dG$.

Like other encryption techniques, elliptic curve encryption is a kind of encryption technique, but its theoretical basis is derived from elliptic curve. In the whole encryption process, it is expanded by points in a finite field. It is necessary to carry out operation and discretization on these points and build corresponding modules, so as to build a special cryptographic system to encrypt and decrypt various information resources. In the process of encryption and decryption, the need to use function means, but generally speaking, are one-way functions; therefore, compared with other systems, its content and operation degree is more complex. To perform an elliptic curve encryption system (ECC), the following steps will be taken: (1) determine the elliptic curve parameters, which are finite field, elliptic curve, and base point; (2) key pair and the relationship between private key and public key is: $Q = kP$. The private key K is a domain element of a finite field, and the public key Q is a point of an elliptic curve. In the previous assumption relationship, A and B are communicating parties, so the parameters of elliptic curve domain can be shared. A is a positive integer as the private key, and the public key can be calculated through the formula. With the private key and public key, the key pair of A can be generated as the public key, and the corresponding key pair of B can be known. Elliptic curve encryption system mainly has the following types: (1) key sharing system: key sharing system is a very important research project in the field of cryptography and has been used in many fields, in life, more common is access control, scheme authentication, etc. One of the key sharing schemes uses the formula ($Q \neq 0$) to share information. However, although this method can achieve password sharing, it is vulnerable to the attack and destruction of the "middle man". To solve this problem, another scheme is proposed; (2) double keys can be constructed according to the specific situation, which are static keys and dynamic keys, respectively (dynamic keys are real-time characteristics, with indeterminate nature); (3) ECES encryption system: checks the MAC addresses to determine the identity of the sender and the sender and generates message masks through the mask function. The plaintext M and the message mask are XOR operation, and the ciphertext is obtained. This is the encrypted process. The next step is the decryption process. After the ciphertext is transmitted to the field of B. The MAC can be obtained through the public key, and the decrypted data will be analyzed and compared with the accepted data. If there is a big difference, the operation will be stopped. If no data error exists, the mask information is calculated and analyzed. The plaintext can be recovered by XOR operation of the mask message and the received encrypted message. It should be noted that the same mask function should be used in the process of encryption and decanting [17].

Theoretical research and calculation need to be verified by experiments, so later hardware operation needs to be verified by software model. In software model verification, addition over finite fields is indispensable. Multiplication and inversion are the key to finite field operations, and the focus of work should be placed in the later resource consumption of hardware, so it is necessary to set up more efficient algorithm programs. Therefore, the particularity generated by GF ((2n)m) in the composite domain is emphatically explored, which can efficiently carry out multiplication and inversion operations and effectively save working time.

In combination with what has been discussed above, we chose the Viretex II device, ISE4.1, developed by XILNX, as the development platform, where the development language is VHDL. The problem faced in this process is mainly the 168-bit elliptic curve encryption algorithm, which involves a huge amount of computation at this point, and therefore, if it is to be implemented, the wiring needs to be considered in a comprehensive manner, and fortunately, Virtex, which provides more extensive wiring resources. Virete can provide and meet most of the features of the FPGA (Field Programmable Gate Way) application market. Especially in the same generation of other products of the same type of chip, the series in the use of the second generation of advanced chip combination module physical architecture. It includes five subseries platforms that implement different functions. The series focuses on the rich resources of FPGAs; each subseries has a high degree of freedom to complement the lack of functionality and resource consumption of the other four series. The corresponding index data are obtained in Modelsim, and the overall operation rate is relatively high. However, if it is the first encryption or decryption, a certain buffer time is needed, but the subsequent plaintext decryption only needs 2 ms. Therefore, this high rate can be adapted to a variety of different occasions. Since the advent of the concept of public key cryptography, quite a few public key cryptosystems have been developed. The security of almost all of these developed systems depends on a different mathematical problem. So far, part of the public key system has been successfully decoded. Of all the remaining public key systems, only the following three are recognized as safe and effective:

(i) IFP, integer factorization, stands for RSA, and so on

(ii) DLP, discrete logarithm, stands for DSA, etc.

(iii) ECDLP, discrete logarithm of elliptic curve, stands for elliptic curve (ECDSA), etc.

To solve the above problems, mathematicians and computer scientists in academia and the world have not found an efficient algorithm after years of calculation, although all these problems have not been proved to be difficult to solve mathematical problems. When the concept of elliptic curve cryptosystem was first put forward, the concept of elliptic curve only stayed in the field of mathematics, lacking the concrete conditions for practical implementation. Due to the security of ECC itself, there is no obvious vulnerability, and the ECC system has been developed rapidly later. Since 1985, ECC has gradually come into the eyes of many cryptographers, computational scientists, and mathematicians and has received full attention. Until today, ECC has become an efficient public key cryptosystem. ECC stands out from many cryptosystems because of its low time complexity in solving mathematical problems. Here, RSA and DSA are taken as examples. The algorithms of these two systems are the same, and they share the same academic source, namely, the time algorithm of subexponential [18]. This shows that the difficulty and length of the problem are directly proportional, that is, the difficulty increases with length. Therefore, although ECC has the same security as IFP and DLP [19], the key length of ECC is much smaller than that of IFP and DLP. Elliptic curve encryption is related to software implementation. The advantage of software implementation is short development time, but the disadvantage is slow encryption speed, which makes the practicality of elliptic curve encryption greatly reduced. The EPGA approach is optimized for this purpose, incorporating the advantages of flexibility and security, faster encryption, and greater advantages in cryptographic applications than ASics.

The characteristics of EPGA hardware and the construction of the model are not completely stripped of the software model, but still need to be based on the software model, and on which to maximize the optimization. At the same time, according to the elliptic curve encryption algorithm, the encryption system can realize modular design, so that different modules can not interfere with each other, complete the setting task independently, but also can share data with each other, coordinate processing, and timing control, so as to improve the encryption effect and improve the security of data transmission.

The application value of ECC far exceeds other traditional public key encryption algorithms, so it has a strong competitive advantage in the field of public key encryption. If purely from the perspective of data encryption, development, and continuous use of ECC is based on the data transmission, the cause of the high safety coefficient is relative to other key system; the system of safety index is higher and can meet the demand of different occasions data transmission, more importantly, the system does not need to be additional to add. Before the ECC system started to be applied, many new public key cryptosystems appeared. However, after the establishment and use of these systems, the risk of being breached is very high, which increases the execution cost. Therefore, ECC has more prominent advantages in key, and the implementation of hardware can further expand its development space.

Among public key encryption algorithms, elliptic curve encryption has high application performance and high encryption effect, so it is widely used in all walks of life. From the point of view of encryption, the ECC system has a higher cost performance ratio, and it can have high security without additional assistance under the established system relationship and meet the security expectations of users. Compared with other public key cryptosystems, even if the system has been established with additional overhead, there is still a large risk of data being breached in the later operation, so the application cost is high. In comparison, ECC system has more prominent advantages and higher cost performance, so it has a broader development space.

ECC system still has higher development potential in the future, because some areas of the system still need to be improved. First is programmable logic devices. In the subsequent research work, it will focus on the aspects of higher gate number and fast rate devices, so as to improve the operation rate of the system. Second is elliptic curve cryptosystem. Elliptic curve cryptosystems still have a lot of room for development, as long as in-depth research and technological development, then can be adapted to more application areas. Third is the hardware implementation of finite field mathematical operation. The hardware implementation algorithm can be improved in the later stage to solve more operational shortcomings and adapt to various forms of key forms. In a word, with the development of modern information technology and science and technology, as well as the change of modern social needs, ECC system will be constantly improved.

5. Conclusion

To sum up, this paper takes ECC system as the research center and discusses in detail the details of each field of the system, operation module design, encryption system implementation, etc. Thesis research results as follows: (1) basic knowledge through research and in-depth analysis of ECC system theory, combining the application problems in the field of e-commerce obtained corresponding solutions, you can use the digital signature, the elliptic curve encryption algorithm, and the combination of symmetric encryption methods; to improve the system in the field of electronic commerce in the encryption speed, reduce the complexity of curve encryption system algorithm; (2) the research object is the modular design of hardware algorithm for elliptic curve encryption system. The influence of finite field selection on the establishment of elliptic curve and the generation of key is analyzed, and the module design of finite field addition, multiplication, and division is optimized. In this process, the realization of FPGA hardware further optimized the design combination of the operation module, and then improved the initial rate, and the system's algorithm logic synthesis ability and simulation can be realized.

In the information age, the risk of data transmission is always greater, and the loss of data once lost or leaked to

individuals or enterprises is inestimable. Therefore, in the network era, more emphasis should be placed on network security, do a good job in the research of elliptic curve cryptosystem, and do not use curve cryptosystem to optimize hardware and software equipment, to ensure the security of information transportation and storage.

In many fields, the use is still more traditional algorithms, such as DES, RSA, and so on, because these algorithms themselves are not complex, less computing time. Due to the complexity of its own operation and the limitation of operation time [20], public key cryptosystem is used in few occasions, mainly focusing on digital signature and other places where identity verification is required. However, the update of the algorithm can improve the user experience of password, and the new algorithm can optimize the process and improve the security of information transmission.

ECC has shorter keys and higher security, so it has strong core competitiveness in this field, and its application scope is constantly expanding. Although the research content of this paper can provide suggestions for the future development of EC, there are still many areas that need to be further studied as follows. First, the number of programmable logic gate has expanded space, and the emergence of faster rate devices has become inevitable. Second, the improvement of elliptic curve cryptography should be paid more attention to. Third, the module design of finite field mathematical operation hardware needs continuous optimization.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declared that they have no conflicts of interest regarding this work.

Acknowledgments

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Retraction

Retracted: Automatic Diagnosis of Elbow Arthritis Based on Edge Algorithm

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] M. Xia, P. Ao, B. Zhang, Y. Liao, and H. Zhao, "Automatic Diagnosis of Elbow Arthritis Based on Edge Algorithm," *Journal of Sensors*, vol. 2022, Article ID 2199262, 8 pages, 2022.

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Research Article

Automatic Diagnosis of Elbow Arthritis Based on Edge Algorithm

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Osteoarthritis is an age-related degenerative joint disease; it is mainly because the cartilage tissue between bones is worn and thinned, which leads to the damage of the periosteum and bone including the surrounding ligaments. Clinically, its manifestations are mainly joint pain, swelling, stiffness, and even partial loss of function, which seriously affects the quality of life of patients. The main clinical manifestations are elbow joint pain and limited movement. Elbow articular cartilage degenerates and falls off, and the more serious manifestation is subchondral hyperosteogeny and sclerosis, which leads to unsmooth articular surface and narrow joint space. Finally, elbow joint pain is severe with different degrees of mobility disorder, elbow joint extension and flexion range is getting smaller and smaller, and elbow joint pain is getting more and more serious. In this paper, the segmentation of left and right elbow images is completed based on gray projection through the analysis of image gray distribution. After obtaining the region of interest of elbow joint, the extraction algorithm of elbow joint hard bone edge is studied. Firstly, the extraction of elbow joint hard bone contour edge is completed based on active shape model algorithm combined with image characteristics. Finally, according to the extraction results of hard bone contour edge, this paper realizes the automatic diagnosis of multiple elbow arthritis indexes and compares with the results given by the image set, which proves that the whole algorithm has good adaptability and accuracy.

1. Introduction

In recent years, with the rapid development of imaging, various modern medical imaging techniques have been widely used in the diagnosis of elbow osteoarthritis, such as X-ray, ultrasound, CT, MRI and so on [1]. These imaging techniques have their own areas of expertise. Sometimes the diagnosis of disease needs to combine multiple imaging techniques to analyze different images of the same disease site. However, X-ray imaging equipment is cheap, and X-ray films are suitable for basic diagnosis, so it is still the most common to observe X-ray films [2].

In today's medical field, both scientific research and clinical application are inseparable from image processing and recognition technology [3]. In the low-level application field, the current medical image-aided diagnosis system has realized simple processing such as image enhancement, geometric transformation, and lesion location selection. These processes enable doctors to see the characteristics of lesions more clearly and improve the diagnosis rate. Furthermore, in the middle-level application, in the field of automatic segmentation of organs and tissues, many techniques in image processing have been applied and achieved good results, such as threshold-based segmentation method, region-based segmentation method, and graph theory-based segmentation method [4]. However, due to the complexity of medical images, the edges of organs and tissues are often blurred, so it is difficult to have a unified segmentation algorithm that can segment all organs and tissues with good results [5]. In the aspect of 3D reconstruction, ITK toolbox, which is developing rapidly at present, can complete the conversion from 2D image sequence to stereo image. This stereo vision conversion technology can not only visually observe the interested tissues but also rotate the three-dimensional structure, so that medical staff are no longer limited to observing the lesions from a certain angle but observe them in all directions to make more accurate judgments [6]. Although image processing technology has made great progress in the field of medical image, most of the technologies are still difficult to be called intelligent, and it needs

to be further explored in the advanced application field of intelligent diagnosis.

2. Research Results of Osteoarthritis

The research on automatic diagnosis of osteoarthritis by using image processing and recognition technology originated in the 1980s. The initial research is mainly based on traditional image processing methods to complete elbow joint region extraction or effective edge detection. Common algorithms include Sobel edge detection, binarization based on area threshold, and so on. However, the difficulty of this kind of image segmentation lies in the blurred edges, and the boundaries between organizations are not obvious [7]. It is difficult to obtain real edges by using traditional digital image processing algorithms alone.

Later, with the development of intelligent algorithms, the research direction of elbow arthritis diagnosis based on image information is divided into two directions: one direction is to study more accurate algorithms to achieve accurate edge extraction of hard bone and cartilage of elbow joint. This direction believes that as long as accurate edges of hard bone and cartilage can be extracted, a series of related parameters can be obtained, and it is not difficult to complete the diagnosis of elbow arthritis according to these parameters [8]; on the other hand, the diagnosis and analysis of elbow arthritis is obtained by doctors according to a large number of film reading experiences, and its diagnostic criteria are vague, so it is not necessary to obtain various index parameters [9]. The algorithm is successful as long as it can classify different symptoms of elbow joint images.

The first direction focuses on region segmentation and edge extraction. In a broad sense, edge extraction and region segmentation are both part of image segmentation algorithm. There are many algorithms for image segmentation. From the initial threshold segmentation to the recent machine learning segmentation methods, threshold segmentation algorithm is a basic segmentation algorithm in image segmentation, which can achieve good results in extracting the region of interest of elbow joint. With the progress of image algorithm research, segmentation methods based on region growing method and active contour model have made new progress. Some scholars have realized the cartilage region segmentation in nuclear magnetic resonance images by using the image segmentation method based on region growing method. In the field of medical image segmentation, region growing method is often combined with traditional edge detection methods, which complement each other and often make the segmentation effect more ideal. Active contour model is used to segment cartilage region in 3D image [10]. Active contour model is based on the concept of energy functional to find the boundary curve of region segmentation. According to different definitions, it can be divided into geometric active contour active model and parametric active contour model [11].

The research in the second direction comes into being with the rise of deep learning research, which does not advocate edge extraction and does not need to set features artificially. Instead, with the help of neural network's powerful learning ability, it can classify images directly. Scholars put forward a new idea: abandoning the features of manual design and assuming that computers can observe weaker changes than human eyes, so as to realize data-driven classification. In this paper, several statistical features are specified to observe their sensitivity to the diagnosis of elbow arthritis. After calculating all the feature values of a given test image, the obtained feature vectors are classified by using a simple weighted nearest neighbor rule, thus realizing the diagnosis of elbow arthritis [12]. Some scholars have published a paper on quantifying the severity of elbow arthritis by using deep convolution neural network. This paper introduces the research results of deep learning into the diagnosis of elbow X-ray films and adopts the mean square error loss function, taking 70% of the pictures in the data set as training sets and 30% as test sets.

According to the diagnostic requirements of elbow arthritis, the problem of the first research direction is that the accuracy of edge extraction is not enough. The research index mainly selects elbow joint space distance as an index to diagnose the severity of elbow arthritis. It is undeniable that the distance between elbow joints is the most important index to judge the severity of elbow arthritis, but besides, the amount of osteophyte, edge sclerosis, and meniscus cartilage calcification also plays a vital role in the diagnosis of elbow arthritis, which should not be ignored when designing the diagnosis system. The second research direction lies in the coupling of multiple indicators. Although the classification accuracy is improved through deep learning algorithm, it is more important for clinical diagnosis to obtain various indicators.

3. Automatic Diagnosis Model of Elbow Joint Based on Edge Algorithm

3.1. Image Preprocessing. Due to the difference of X-ray energy or the narrow nonlinear dynamic range of imaging equipment, the exposure degree of images is different, the exposure of some images is too unbalanced, the whole image is dark, and the gray distribution range is narrow, which is difficult to identify visually and seriously affects the subsequent processing links. In order to make the visual effect of the image stronger and the detail resolution easier, this paper extends the gray level of the image to 0-255. There are many common gray level transformation algorithms, such as linear transformation, exponential transformation, logarithmic transformation, and histogram equalization. Because the gradient of each point must be calculated in the later processing, if the gray level transformation algorithm such as nonlinear or histogram equalization is adopted, it is easy to change the relative gradient of the image. In order to keep the gradient of each pixel relatively invariant, this paper chooses to use linear transformation to stretch the gray level of the image to 0-255, which is described as follows.

If the gray distribution interval of the original image is $[m, n]$ and the transformed gray distribution interval is $[s, t]$, the formula can be used:

$$g(x, y) = \frac{(t - s)[f(x, y - m)]}{n - m} + s. \quad (1)$$

In image processing, the core of Gaussian smoothing is a two-dimensional convolution kernel using the characteristics of Gaussian function. The convolution kernel is used to suppress noise and blur the image. According to the characteristics of Gaussian distribution, the value of the central pixel in Gaussian distribution is the largest, so its weight ratio is also the highest. With the increase of the distance from the central pixel, the weight ratio of other pixels in the neighborhood of the central pixel is getting lower and lower. In theory, all pixels around the center point need to contribute weights, but the window size of convolution kernel is limited in actual calculation. According to the definition of small probability events in probability statistics, the contribution of pixels outside the center of the mean value can not be considered. Therefore, in image processing, the same idea can be adopted to intercept the square with finite side length centered on the point to be smoothed as the boundary area to lock those pixels that contribute weights to the pixels to be smoothed. In this paper, Gaussian convolution kernels of different sizes are repeatedly tried in the processing process to determine the optimal convolution kernel for the subsequent algorithm. Finally, it is found that when the Gaussian convolution kernel is $7*7$, the processing effect for the subsequent algorithm is the best. The convolution kernel is shown in Figure 1.

1	4	7	10	7	4	1
4	12	26	33	26	12	4
7	26	55	71	55	26	7
10	33	71	91	71	33	10
7	26	55	71	55	26	7
4	12	26	33	26	12	4
1	4	7	10	7	4	1

Figure 1: Gaussian convolution kernel.

3.2. Automatic Diagnosis Model of Elbow Joint Based on Edge Algorithm

3.2.1. Sample Selection and Feature Labeling. In the segmentation method based on active shape model, the construction of initial model is very important, and to build a representative initial model, it is necessary to select appropriate samples, so the selection of samples is the foundation and an important step. First, select n sample images as training samples. The selection principle should follow diversity and representativeness; for example, the orientation of elbow joint is oblique to the left and oblique to the right and vertical. The position of elbow joint is left, right, and middle, and the size of elbow joint is also slightly different. Various diseases of elbow joint lead to the change of elbow joint space and edge, all of which should be fully considered to avoid the limitation of sample selection. After selecting samples, we need to label the feature points of these samples and manually mark K key feature points of the target object in N samples, and the selection of feature points is based on the contour edge. Because the edge detected by Canny edge detection is the finest and the integrity is relatively good, the results of Canny edge detection are used to assist the selection of feature points. Taking the sampling and selection of feature points at the lower edge of femur as an example, sampling should not only ensure that the number of sampling points can describe the shape of the contour but also avoid the redundancy of information caused by too many sampling points. Generally, the points with high curvature and T-shaped joints are selected first, and the other feature points are arranged among the above points at reasonable intervals in order. As shown in Figure 2, the selection process of feature points of elbow joint femoral edge is described.

In Figure 1, the larger dots are typical feature points, and the smaller dots are feature points added equidistantly between typical feature points to depict a complete shape. After selecting feature points, the coordinates of K feature points in an image are sequentially formed into a shape vector such as formula

$$X_i = (x_{i1}, x_{i1}, x_{i2}, x_{i2}, \cdots\cdots, x_{ik}, x_{ik}), \tag{2}$$

where (x_{ik}, x_{ik}) is the coordinates of the k-th feature point in the i-th image.

Thus, the length of each shape vector is 2 K, and n samples can form n shape vectors, thus obtaining a sample set $J = \{X_1, X_2, \cdots\cdots X_n\}$.

3.2.2. Sample Shape Alignment and Matching. The shapes of elbow joints are quite similar. For example, there will be an upward groove in the middle of the lower end of the femur, and the medial femur is usually larger than the lateral femur and so on. However, due to the slight inclination angle and orientation change of femur in training samples, in order to eliminate the interference of nonshape information caused by the standing posture and bone size of the subject, it is necessary to align n shape vectors, which is called aligning shape vectors. The method adopted is Procrustes alignment. Generally speaking, general alignment is an affine transformation between shapes sought by using the idea of least square method. The basic steps are as follows:

(1) After aligning to the origin, the shape vectors of the target objects in all training images are aligned to the shape vectors of the target objects in the first image, and the first shape vector should be normalized to the unit size

(2) Calculating the average value $\bar{X} = (1/n)\sum_{i=1}^{n} X_i$ of the shape vector of the target object

(3) Aligning all the shape vectors generated in the first step to X

(4) Repeat steps 2 and 3 until convergence (the difference between two adjacent times is within a given threshold)

E the expression to get the minimum value:

$$E = \left(X_i - F(s,\theta)\left[X_j\right] - m\right)^T W\left(X_I - F(s,\theta)\left[X_j\right] - m\right). \tag{3}$$

Figure 2: Sampling schematic diagram of femoral edge of elbow joint.

Because $F(S, O)$ stands for rotation and contraction transformation, we can deduce the formula

$$F(s,\theta)\begin{bmatrix} x_k \\ y_k \end{bmatrix} = \begin{bmatrix} (s\cos\theta)x_k - (s\sin\theta)y_k \\ (s\cos\theta)x_k - (s\sin\theta)y_k \end{bmatrix}. \quad (4)$$

The diagonal element of the weight diagonal matrix W is the weight W_k of each marker point; it represents the stability of the marking point. Taking the femoral edge as an example, some characteristic points are relatively stable, such as the groove vertex in the middle of the lower femur and the turning point on the left and right sides. Improving the weight of these points can effectively improve the accuracy of matching. Mark the distance of the k-th feature point and the i-th feature point in an image as R_{ki} (still in the order of the origin mark), and the n images can get n distances, and $V_{R_{ki}}$ represents the variance of nR_{ki}, then

$$W_k = \left(\sum_{i=1}^{n} V_{R_{ki}}\right)^{-1}. \quad (5)$$

Order, available formula is as follows :$a_x = s\ \cos\theta, a_y = \mathrm{s}\ \sin\theta$

$$\begin{bmatrix} X_2 & -Y_2 & W & 0 \\ Y_2 & X_2 & 0 & W \\ Z & 0 & X_2 & Y_2 \\ 0 & Z & -Y_2 & X_2 \end{bmatrix}\begin{bmatrix} a_x \\ a_y \\ m_x \\ m_x \end{bmatrix} = \begin{bmatrix} X_1 \\ Y_1 \\ C_1 \\ C_2 \end{bmatrix}. \quad (6)$$

3.2.3. Dimension Reduction of PCA. PCA is principal component analysis, assuming that the number of feature points in each sample in the training set is k; then, a 2k-dimensional space is needed to process these shape vectors. Generally speaking, when K is large, it is difficult to deal with such a high-dimensional vector. In order to reduce the difficulty of processing, it is necessary to select some important features to describe the shape, that is, dimension reduction. The purpose of dimension reduction is to greatly reduce the redundancy of information while retaining most effective information. The most commonly used dimension reduction method is PCA (principal component analysis) processing, and the steps are as follows.

Calculate the average shape vector:

$$\bar{X} = \frac{1}{n}\sum_{i=1}^{n} X_i. \quad (7)$$

Calculate the covariance matrix:

$$S = \frac{1}{n-1}\sum_{i=1}^{n}\left(X_i - \bar{X}\right)^T\left(X_i - \bar{X}\right). \quad (8)$$

The eigenvalue λ_i and the corresponding eigenvector p_i of the covariance matrix are found, and the eigenvalues are arranged in a decreasing order, and the eigenvector corresponding to the previous eigenvalue will have the main effect on the shape vector. We select the first t eigenvectors to satisfy the formula

$$\frac{\sum_{i=1}^{t}\lambda_i}{\sum_{i=1}^{m}\lambda_i} > k. \quad (9)$$

Selecting feature vectors like this can keep the original shape and reduce the computational complexity. In this way, any shape vector participating in training in the training image can be expressed as a linear combination of feature vector sets, as shown in the formula:

$$X_i = \bar{X} + PB. \quad (10)$$

3.2.4. Constructing Local Gray Model. Principal component analysis adjusts the shape as a whole. Next, the shape needs to be iterated to the real contour edge, and each iteration needs to find a new position for each feature point, while the local gray model can provide the direction of iterative development. Here, the concept of gray gradient is used to define local features for each feature point. For the i-th feature point, the creation process of local features is shown in Figure 3.

In the j-th training image, m pixels on each side of the i -th feature point are selected on the normal line of the i-th feature point (here, the normal refers to the vertical line connecting the previous feature point of the feature point and the second feature point), thus forming a vector with $2m + 1$ component. As shown in the following equation, each pixel on this vector is first-order guided, and the result of the operation is called local texture g_{ij}. The i-th feature point on the other images in the training set does the same work, and all the local texture about the i-th feature point g_{i1}, g_{i2}

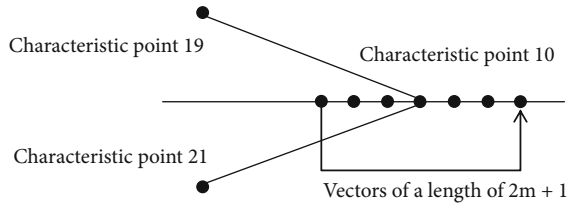

Figure 3: Description diagram of local feature creation.

Figure 4: Maximum binary diagram.

$, \cdots\cdots, g_{\text{in}}$.

$$g_{ij} = \left(g_{ij1}, g_{ij2}, \cdots\cdots, g_{ij(2m+1)}\right)^T. \quad (11)$$

3.2.5. Model Initialization Positioning. When the model covers the target image, it needs initialization positioning. The accuracy and efficiency of ASM algorithm depend on the accuracy of initialization positioning. If the initialization positioning is far away from the real contour edge, the target may not be searched. If the initial location is close to the real contour edge, it can not only increase the accuracy of matching but also improve the speed of search, so it is necessary to transform the average shape vector properly to get a reasonable initial position.

The standardized model uses initialization and positioning methods, and generally uses the maximum threshold method to binarize the segmented image shown in Figure 4. The average shape model is randomly overlaid on the binary image, but to ensure that the longitudinal lowest point of the average shape model should not be lower than the elbow joint space, then, the head and tail point vectors of the average shape model are connected to form a closed area, and the average shape model is rotated and translated to make the white pixels in the closed area account for the largest proportion of the total pixels in the area. At this time, it can be considered that the initialization and positioning of the model are completed. The operation of rotation is limited by angle, while the operation of translation is unlimited

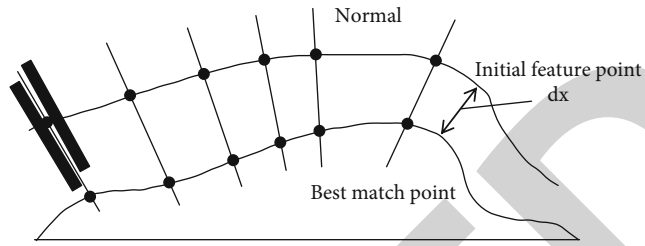

Figure 5: Schematic diagram of search process.

in left and right directions and limited in up and down directions.

The initial location of the posterior edge of the superior tibial plane is similar to that of the inferior femoral edge, while the initial location of the anterior edge of the superior tibial plane relies on the posterior edge and iterates on the basis of the posterior edge.

3.2.6. Local Search Processing. After the preliminary model is established, the initial ASM model is covered on the image, and the next step is to find the new iterative position of the feature points by using the local gray model of the feature points. The schematic diagram of the search process is shown in Figure 5.

The big mark points on the outer side of the graph are the initial feature points, and the small mark points on the lower side of the graph are the best matching points of the model. The normal direction of the feature points refers to the perpendicular line connecting the front and back feature points of the initial feature points, and the iteration of each feature point moves along the normal direction. The thick line segment on the left side of the normal is $2m + 1$ pixels selected in the local gray model, and the thick line segment on the right side of the normal represents the search area when the feature points are iterated. The distance between the initial point and the best matching point is the distance dX that the initial feature points should move.

A local feature is obtained by normalization, which contains $2(v - m) + 1$ sublocal features in total. Because the normalized gray vector approximately obeys Gaussian distribution, Mahalanobis distance can be used to express the similarity between the new feature g of a feature point and its trained local feature. The calculation formula of Mahalanobis distance is as follows:

$$F_s = (g - \overline{g_i})S_i^{-1}(g - \overline{g_i})^T. \quad (12)$$

The smaller the Mahalanobis distance, the greater the similarity, and the closer the boundary point I in the model is to the boundary point I in the target, so the best position of the boundary point can be determined by this method. Then, calculate the Mahalanobis distance between these sublocal features and the local features of the corresponding feature points in the gray model.

When the Mahalanobis distance is minimized, the center point of the corresponding sublocal feature is the new position of the current feature point, and all feature points undergo the same steps, so each point will have a

Figure 6: Detection results of iterative process.

(a) (b)

Figure 7: Schematic diagram of inferior femoral angle and superior tibial angle.

displacement, and these displacements will be arranged into vectors, such as the formula:

$$D_X = D_{X1}, D_{X2}, D_{X3}, \cdots\cdots, D_{Xk}. \tag{13}$$

After all feature points are updated iteratively, a new curve is formed.

3.2.7. Active Shape Model Parameter Update. After the initialization of the shape model and the local search strategy are established, the shape can be updated. Assume that the mapping function from the average shape vector to the initial model is shown by the following formula:

$$X = M(s, \theta)x + m. \tag{14}$$

The obtained model is further similar to the target model, and further matching is carried out by iterative method. The iterative updating process of parameters is as follows:

$$m_x \longrightarrow m_x + dm_x, m_y \longrightarrow m_y + dm_y, \theta \longrightarrow \theta + d\theta, s \longrightarrow s + ds, B \longrightarrow B + dB. \tag{15}$$

As the iteration progresses, when the difference between the two shape models is less than a certain threshold or reaches a given number of iterations, the algorithm ends, stops searching, and thinks that the model converges, and the whole search and matching process ends, and the feature points at this time are the contour edges to be searched. Figure 6 shows the detection results of the lower edge of femur after different iterations, which are 3 iterations, 15 iterations, and 40 iterations from left to right.

4. Automatic Diagnosis Experiment of Elbow Arthritis Based on Edge Algorithm

4.1. Determination of Diagnostic Index. Clinically, some of these indicators are quantitative, such as elbow joint space distance and related angle. Some are nonquantitative and vague, such as osteophyte amount and sclerosis degree. They are all directly related to the symptoms of elbow arthritis. For example, narrowing the distance between elbow joints will aggravate the pain of patients when sitting, standing, and walking. Meniscus calcification can cause gout symptoms in patients. The changes of the upper femoral angle, the lower tibial angle, and the tibial-femoral angle will make the joints turn inside (outside) and so on. If we can automatically measure the quantitative indexes and transform the nonquantitative indexes into statistical quantitative analysis with the help of computers, the diagnosis efficiency will be greatly improved, and the workload of doctors will be reduced. In this chapter, the elbow joint space distance is measured automatically, and the automatic diagnosis results of these three indexes are compared with the results recorded in the reference documents in the image set.

4.2. Automatic Measurement of Elbow Joint Correlation Angle. In the X-ray film of elbow joint, the calculation of elbow joint-related angles including inferior femoral angle and superior tibial angle all depends on femoral physiological axis and tibial physiological axis. The femoral physiological axis is the line between the apex of the interfemoral fossa

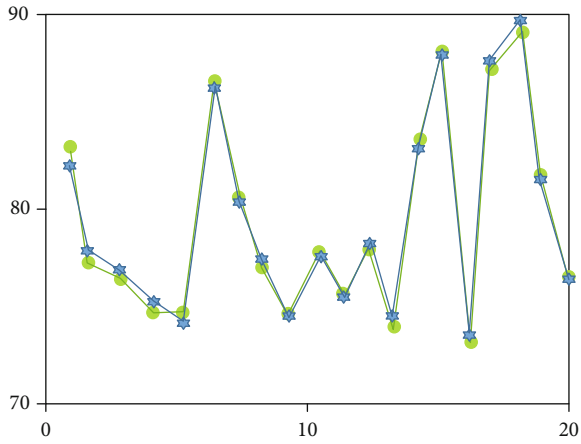

Figure 8: Comparison of automatic and manual measurement of inferior femoral angle.

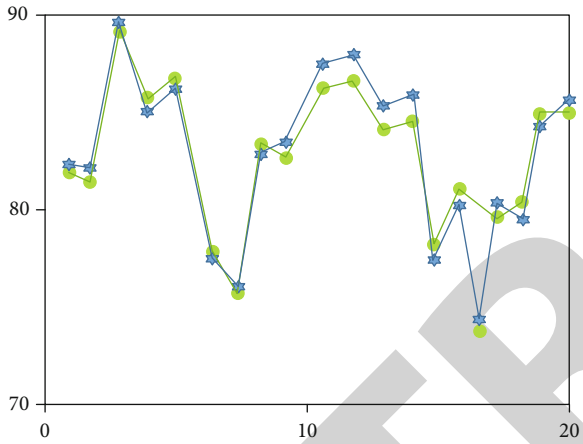

Figure 9: Comparison of automatic and manual measurement of upper femoral angle.

and the midpoint of the femoral axis, and the tibial physiological axis is the line between the intertibial fossa and the midpoint of the tibial axis. The inferior femoral angle is the lateral angle between the tangent line of the inferior femoral edge of elbow joint and the physiological axis of femur, which is generally between 75 and 85. If it is less than 75, it is defined as cubitus valgus. The superior angle of tibia is the lateral angle between tibial plateau and tibial physiological axis. It is generally between 85 and 95, and if it is greater than 95, it is defined as cubitus varus. As shown in Figures 7(a) and 7(b), there are schematic diagrams of inferior femoral angle and superior tibial angle.

Figures 8 and 9 show the comparison between the automatic measurement results of the lower femoral angle, the upper tibial angle, and the femoral tibial angle of the right hand of 20 images in the image set and the manual measurement results in the reference document. "Solid blue six-pointed star" stands for automatic measurements, and "green circle" stands for manual measurements in reference documentation, in deg. It can be seen from the results that the automatic measurement results are in good agreement with the manual measurement results.

5. Conclusion

In recent years, with the rapid development of imaging, various modern medical imaging technologies are widely used in the diagnosis of elbow osteoarthritis, such as X-ray, ultrasound, CT, and MRI. These imaging technologies have their own fields of expertise. Sometimes, it is necessary to combine various imaging technologies to analyze different images of the same diseased site for the diagnosis of diseases. In this paper, the automatic diagnosis of elbow osteoarthritis is completed based on X-ray image information. Firstly, the region of interest of elbow joint is extracted, a small rectangular region where the elbow joint is located is extracted from the whole X-ray image, and then, the contour extraction of hard bone edge in two-dimensional image is realized based on active shape model. Complete the automatic calculation of elbow joint related angle; the edge sclerosis of hard bone of elbow joint was quantitatively analyzed. In this chapter, two indexes, elbow joint space distance and elbow joint related angle, are selected for automatic measurement and quantitative analysis. In the aspect of elbow joint gap distance measurement, firstly, the elbow joint is corrected by rotation to make the automatic measurement of gap distance conform to the clinical medical measurement criteria, and then, the automatic measurement results are compared with the manual measurement results in the reference documents, showing a good agreement.

The accuracy of elbow bone contour edge extraction needs to be improved, and the search rules in active shape model are still being tried to improve the accuracy of the algorithm from two aspects: the original gray model improvement and the subsequent search criteria improvement. The statistical description of various nonquantitative indicators of elbow arthritis needs to be improved. In the future, the quantitative analysis of all nonquantitative indicators should be completed to promote the comprehensiveness of automatic diagnosis of elbow arthritis.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

Authors' Contributions

Minwei Xia and Peng Ao contributed equally to this work.

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Retraction

Retracted: Deep Learning-Based ECG Abnormality Identification Prediction and Analysis

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] W. Liang, "Deep Learning-Based ECG Abnormality Identification Prediction and Analysis," *Journal of Sensors*, vol. 2022, Article ID 3466787, 9 pages, 2022.

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Research Article

Deep Learning-Based ECG Abnormality Identification Prediction and Analysis

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In recent years, China's economy has been developing rapidly, and people's life and quality of life have been improving; more importantly, people's habits and living habits have also developed from the previous "unhygienic" and "not very careful" to the current "Healthier, more hygienic, greener and more sophisticated" direction. In the process of this development, due to the rapid development of the economy and the industrialization of cities, the incidence of heart disease is also increasing year by year. According to relevant studies, China's urbanization process has been unprecedented, the number of urbanized people in China has exploded in recent years, and the ratio of urban to rural population has increased from about 20 percent to about 75 percent today. The effects of the population and the urbanization of urban architecture are affecting people's physical and mental health, both consciously and unconsciously, causing both positive and negative physical and mental effects on the psychological and physical levels. In this paper, the concept of deep learning is fully utilized to train the CNN neural network model and apply it to the ECG abnormality recognition and prediction examination. In order to fully validate the application and significance of deep learning in ECG abnormality identification and prediction, the whole project was completed through subjective and objective experiments. The experimental results show that, from the subjective aspect, the ECG examination has been accepted by most people for different age groups, and the analysis results of the ECG examination with the deep learning model in this paper are more satisfactory; from the objective aspect, the CNN-ECG abnormality recognition prediction network model trained in this paper has high. The accuracy of the model for ECG abnormality recognition prediction can reach 86% when the learning rate is set to 0.0001 and the batch size is set to 120, and the model can reduce the burden of medical personnel to a certain extent.

1. Introduction

The heart is a very important component of our human organism [1]. According to related studies, the incidence of major diseases is much higher in first-tier cities than in smaller cities [2]. There are many reasons for this phenomenon, one of which is the urban pollution and the fact that in the process of urbanization, only economic development is emphasized without paying attention to the human factor, and a large number of tall buildings are erected but the construction of urban greenery is neglected; all these factors lead to the aggravation of urban pollution, and more importantly, people live in a depressing environment without humanistic care for a long time, which greatly affects the human body. This can lead to depression and boredom and lack of emotional release and healing, which is also one of the important factors that lead to the emergence of physical health [3].

The heart, as the "source of everything" in the human body, not only controls the operation of the whole body but also acts as the "commander-in-chief" and "master controller" of blood circulation; so, many diseases in the human body may be related to the heart. Therefore, many diseases in the human body may be related to the healthy operation of the heart, such as coronary heart disease, chest tightness and shortness of breath, and cardiac arrhythmia [4]. According to a study [5], some patients suffer from stomach problems for years, and then during the treatment process, they have been taking medicines that harmonize the stomach and promote digestion and absorption, and after a period of treatment, the patient's stomach disease improved, but

pathological phenomena such as chest tightness and shortness of breath and arrhythmias appeared. After deducing that the patient's stomach disease was probably a "minor illness" and a distress signal sent by the heart through the stomach, the doctor arranged for the patient to be hospitalized and undergo an electrocardiogram (ECG). The doctor later arranged for the patient to have a 24-hour ambulatory electrocardiogram and a cardiogram and finally deduced that the patient had unintentionally developed symptoms of coronary artery blockage but eventually got better after the corresponding treatment. Through the above case study, it is known that in real life, many diseases are likely to be related to the heart; so, regular cardiac examination is worthy of attention as well as essential [6].

And ECG, as a very common way to check the health of the heart, plays a very important role in the process of confirming many diseases [7]. The research on ECG abnormalities is also advancing year by year, such as a research scholar specifically for the analysis of ECG abnormalities in the elderly population [8]; in the paper, the authors firstly analyzed the relevant basic data and clarified the criteria to be used and the determination of the index observation and then used the method of organizing and analyzing the data through statistical methods. The final results of the experiment showed that the number of people with abnormal ECG results was about 1800 out of 3,000 elderly medical examinations, accounting for more than 60%, which shows that ECG examination is extremely important for the safety of human health. In addition, some researchers have conducted ECG abnormalities in different age groups of pregnant women, and the authors firstly analyzed the data and methods implemented in the ECG examination of pregnant women and performed ECG abnormalities in all pregnant women using the conventional 18-lead tracing method. It was found that the ECG of pregnant women at different ages had more or less problems, especially in the middle and late stages of pregnancy, and this study has a positive meaning and reference significance for both pregnant women and fetuses, because pregnant women with ECG abnormalities can receive timely attention and effective treatment.

In summary, due to the continuous development and expansion of social economy, people's lifestyle has also undergone radical changes, the process of urbanization has also been promoted unprecedentedly due to the rapid expansion of the economy, and it is due to the influence of the abovementioned factors that many cities do not want "green and natural harmony" ecological construction as long as the economic development. Long-term life in the lack of green health will lead to a depressed mood, which will lead to human health problems. As a result of the above analysis, the diagnosis of many diseases is ultimately related to the health of the heart; so, the study of ECG abnormalities is one of the most important academic research on human health and life [9].

However, most of the studies and methods on ECG abnormalities nowadays are focused on specific populations or specific drugs, and these studies generally select certain target populations as the subject of investigation and research, then perform ECG examinations on them, and then discuss and analyze the examination results through corresponding statistical techniques. The results of such studies have a certain target audience and are to some extent one-sided. Because heart problems are not only age-related but also related to other factors such as regional environment, the study of ECG abnormalities should be more comprehensive and have more target audiences, and secondly, the identification and prediction of ECG abnormalities in the general population are an important tool for the prevention of heart problems.

2. Background of the Study

2.1. Modes of Cardiac Screening and Its Importance. The importance of the heart to human health in life cannot be overstated, and regular medical examination of the heart is one of the most important ways to focus on the health and safety of life. There are many ways to examine the heart, and one of the most common and routine ways is the electrocardiogram. It is often used to find out whether a patient has arrhythmia or myocardial ischemia and is one of the most widely used cardiac examinations for clinical diagnosis in major hospitals. There are various forms of ECG, including cardiac ultrasound, 24-hour ambulatory ECG, exercise panel test, and coronary CT [10].

The first is the cardiac ultrasound, which is also known as color Doppler echocardiography; in the diagnosis of patients first by using an ultrasound probe to scan the patient's chest, which in turn can obtain images of heart sections in different directions of the same patient's heart, and not only that, the operator can also obtain parameters related to the patient's heart function through the device, and in combination with the above images and based on these images and parameters, a comprehensive evaluation of the patient's heart can be performed to determine whether there are any abnormalities in the heart function and to provide a reference basis for the subsequent treatment [11]. After obtaining an ultrasound image of the heart, the clinician can also analyze in detail whether the blood flow distribution in the heart is normal and whether the echogenic signal of the heart is within a reasonable range to obtain a comprehensive assessment of the patient's heart function [12]. Among them, cardiac ultrasound not only helps physicians to determine the patient's condition more rationally but also to determine more accurately whether there is myocardial insufficiency and other complications caused by myocardial problems in the patient's heart.

The second is the 24-hour ambulatory electrocardiogram. A 24-hour ECG is performed by wearing a special recorder for 24 hours, which is used to record all changes in the activity of the heart and in the quiet state, in order to check all indicators of the heart. With the help of 24-hour ambulatory ECG, all changes that occur in the patient's heart over a 24-hour period can be recorded to capture in great detail the various abnormalities that occur in the heart and also to record the changes in the relevant indicators when the abnormalities occur, providing a certain medical basis for the subsequent diagnosis and treatment of abnormal heart problems [13].

The third modality is the routine ECG examination. Routine ECG is a very common and basic item in the body's own examination program, it can quickly respond to obvious abnormalities in the heart, such as arrhythmia or myocardial ischemia, but it is more difficult to detect some abnormalities that are not obvious, and some patients' heart abnormalities are likely to be intermittent; so, when routine ECG is done, heart abnormalities are not always detected [13].

The last type is the exercise plate test. As shown in the test, the patient has to walk on a treadmill-like plate, but unlike a normal treadmill, the speed and gradient of the exercise plate can be adjusted, so that the physician can test the patient's exercise load by using the device with the appropriate walking speed and different gradients, and the patient's heart rate, blood pressure, and heart rate can be measured during or after the exercise [14]. The patient's heart rate, blood pressure, and ECG changes are observed during and after exercise [15].

2.2. Significance of ECG Abnormality Identification for Human Health. The heart is known to be a very important organ in the human body, and it is also extremely fragile, and if it is not cared for in a timely manner and checked regularly, then heart problems can easily lead to sudden death [16]. In addition, the heart is closely related to the quality of human life, as every beat of the heart is working for blood. The heart is the "pump" that allows nutrients and oxygen from the blood vessels to reach all parts of the body easily, so that the human body can maintain normal operation. An electrocardiogram is a common clinical test for heart disease. It is an important way to measure and diagnose the presence of abnormalities in the heart. Therefore, the prediction and analysis of ECG abnormality identification are a meaningful study in itself and are able to provide some medical basis for the development of ECG examination as a program [17].

In summary, in this paper, a specific dataset will be formed by collecting ECG data related to the study subject and then using deep learning methods to estimate and predict and analyze the accuracy of the collected dataset.

3. Materials and Methods

3.1. Evaluation Indicators of ECG Abnormalities. In medicine, heart problems can be diagnosed by whether the ECG is abnormal or not. If a human body experiences symptoms such as chest tightness, shortness of breath, chest discomfort, or chest pain, it is generally recommended to have an ECG examination to determine whether there is a problem with the heart. Therefore, ECG examination is of great significance in confirming the diagnosis of whether a patient is suffering from a heart-related disease. And the presence of abnormal ECG problems can be diagnosed by observing the following indicators [18].

3.1.1. Atrial Flutter and Atrial Fibrillation. Atrial flutter and atrial fibrillation are two of the two symptoms that produce abnormalities in the heart. In the case of atrial fibrillation, the most common cause of this symptom is due to arrhythmia, which is manifested on the ECG by the absence of the p-wave that should be present in a normal cardiac examination and the production of an F-wave of a different shape and size instead, where the F-wave, also known medically as a fibrillation wave, is one of the most important indicators to confirm the presence of a heart rate market. In addition, if atrial fibrillation is diagnosed, the QRS waves in the ECG will be of unequal spacing and will be completely irregular and chaotic. In atrial flutter, if the heart rate is as high as 250 to 350 beats per minute, then atrial flutter is judged to be present. Atrial flutter is an arrhythmia of the heart rate, most of which occurs in the atria, and is manifested in the ECG by the absence of P-waves and the presence of flutter waves. Unlike fibrillation waves, flutter waves are also an F-wave, but they appear in the same shape, size, and spacing.

(1) Preexcitation syndrome: it is caused by premature excitation of the ventricular muscle and is manifested on the ECG by a shortened P-R interval and a series of abnormal widened QRS waves

(2) Ventricular tachycardia: this symptom is caused by structural changes in the heart organ and is a serious heart disease. It is characterized by more than three or more premature ventricular beats in the electrocardiogram, and instead of a P-wave, a QRS wave with a width of more than 0.12 s is generated, accompanied by secondary ST-T changes, and the frequency of these changes is between 110 and 200 beats per minute. Another type of ventricular tachycardia is torsional ventricular tachycardia. As the name implies, ventricular tachycardia is obviously associated with arrhythmias, and torsional ventricular tachycardia is caused by various reasons that lead to prolonged ventricular repolarization, which results in a prolonged Q-T interval on the electrocardiogram and a wide frontal P-wave deformity, so that the QRS wave group flips up and down from the baseline

(3) Block: there are many different types of supracardiac block, including double bundle branch block, first degree block, second degree type I AV block, left bundle branch block, right bundle branch block, and complete AV block. Bifascicular block is a condition that affects the conduction of fibers that transmit electrical signals in the subendocardium of the ventricle, resulting in a lack of cardiac function, and is characterized by a significantly higher number of QRS waves than normal on the electrocardiogram, as well as aberrations and slower frequency. Complete atrioventricular block, on the other hand, is caused by the complementary effects of the ventricles and atria working separately. In this case, the most characteristic feature is that the atrial frequency is significantly higher than the ventricular frequency, while the ventricular block is usually below the usual site and the frequency beats between forty and sixty

times per minute; so, the ventricular frequency is mostly slow, but the QRS wave groups are basically normal

3.2. Deep Learning for ECG Examination. In the last decade, deep learning has gradually developed better and started to play its role and significance in various fields, and it is no less important in the medical field. Deep learning has been developed not only in image processing and target detection but also in the field of medicine, where it has been applied to promote the development of medicine and contribute to the safety of human life. For example, some researchers have applied deep learning methods to medical image analysis [19], in which the authors mainly improved the DenseNet neural network to adapt it to the medical imaging field and introduced the U-Net network to the original DenseNet neural network. The improved DenseNet neural network model is trained by preprocessing the virus data set using the principle of image enhancement, which can be applied to other virus sample data sets with a little processing. It can be seen that the ECG examination with deep learning not only has a certain accuracy but also the portability in deep learning brings a broad prospect for the development and application of ECG examination under deep learning.

3.3. Overview of ECG Abnormality Identification and Prediction with Deep Learning. Deep learning is a special kind of "machine learning," which is one of the learning modes included in the field of artificial intelligence. For deep learning, it can represent the world as a nested hierarchy with certain concepts and certain meanings by imitating human learning and thinking behaviors, so that it can obtain a powerful ability and good flexibility to realize the connection of every unknown and known concept: the more abstract concepts and matters through certain "equations. The process of training and connecting every unknown and known concept, and connecting the more abstract concepts and matters through a certain "equation," which can lead to an ideal model that is more in line with people's expectations, can be called "deep learning" [20]. And based on this certain "equation," we can call it an algorithm. One of the deep learning under artificial intelligence is shown in Figure 1.

For Figure 1, we can see that deep learning is based on a branch in the field of artificial intelligence, there is a "connection point" between this branch, and there is a "connection point" we can call "machine learning." So, what is the difference and connection between machine learning as a "connection point" between AI and deep learning and the deep learning discussed in this paper?

Deep learning is a much better neural network approach than machine learning. The most important difference is that deep learning can use algorithms to automatically identify the important features we need to recognize and classify something. For example, in this paper, for ECG abnormality identification and prediction, we use deep learning algorithms to help reduce the workload of health care workers because the trained deep learning models can automatically identify ECGs with abnormalities. So, on this basis, it can

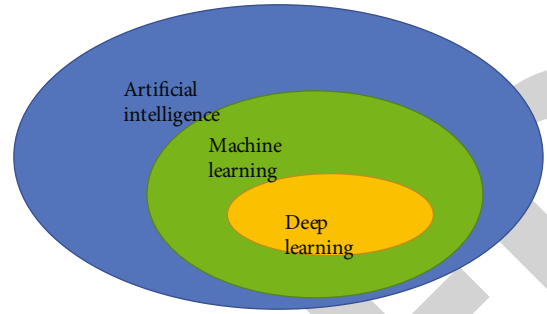

Figure 1: Deep learning under artificial intelligence.

reduce some manual input and enable the health care workers to try to spend their most important work elsewhere.

The history of deep learning can be traced back to the 1980s, when a new perceptual machine called heuristic neural networks appeared in the early 1980s; by the mid-1980s, a recurrent neural network called RNNs appeared, but the practical application under deep neural networks was finally realized in the 1990s, and such DNNs were not practically applied due to the practical application of such DNNs which was not widely used due to the limitation of hardware. The development of deep learning fell into a bottleneck stage. By the beginning of this century, the concept of deep belief networks was proposed, and the hierarchical pretraining framework was likewise developed, so that deep learning ushered in a larger development and gradually became well known and continuously developed. Therefore, in view of the advantages of deep with strong learning ability, and also strong adaptability and wide coverage, this paper will use the relevant neural network algorithm under deep learning to realize the research on the method of ECG abnormality recognition and prediction, will realize the method of recognizing the ECG abnormality of different target audience groups based on both subjective level and objective level, fully explore the deep learning in medical field, and provide some theoretical basis and practical value for the subsequent deep learning can be used in other aspects of medical field or ECG.

4. Results and Discussion

From Section 3, it is known that for the abnormal recognition of ECG, it is very important for the assessment and prevention of human health and quality of life; therefore, this paper will make some research and prediction on the abnormal recognition of ECG based on the theory of deep learning, which is indicated above by the deep learning algorithm. However, in this paper, in order to fully consider the human characteristics and the concept of human-oriented medical treatment, we will evaluate the subjective aspects of different target audiences based on the objective aspects mentioned above, i.e., we will conduct research on the abovementioned objectively surveyed people by means of questionnaire star and then organize and analyze the obtained results to realize the objective and subjective analysis of ECG abnormality detection under deep learning in

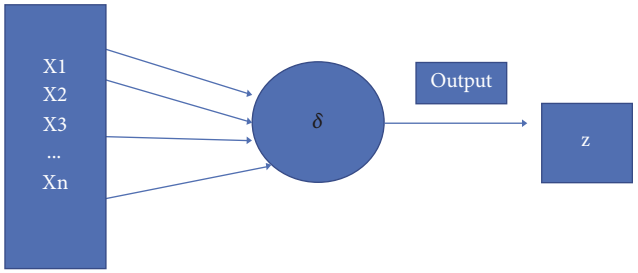

Figure 2: Basic block diagram of neuron.

this paper. The objective and subjective analysis of ECG abnormality detection with deep learning is realized.

4.1. Prediction of ECG Abnormalities with CNN Networks. Both deep learning and machine learning are similar for data processing, and CNN network is a kind of neural network under deep learning. In essence, deep learning is also a neuronal model, i.e., it is composed of many basic neurons, each of which is shown in Equation (1).

$$z = \delta(w1x1 + w2x2 + \cdots + w_k x_k + b). \quad (1)$$

As can be seen from Equation (1), z denotes the output of a certain neuron model, b denotes the bias value or bias function, δ is the activation function, and w1, w2, ..., wk denote the weights. The basic block diagram of a neuron can be drawn according to Equation (1) as shown in Figure 2.

From Figure 2, the basic block diagram of a neural network can be composed of three parts: input x1, x2, x3, ..., xn, activation function, and output. The deep learning algorithm is essentially a layer of complex network structure, and this paper is to take the basic block diagram of this neural network as the basic so as to make some extensions to form a more complex deep learning neural network model with acceptable accuracy in the range of ECG abnormality recognition. And in neural networks, different activation functions are generally selected according to different tasks, among which the more common activation functions are as follows.

$$f(x) = \frac{e^x - e^{-x}}{e^x + e^{-x}}, \quad (2)$$

$$f(x) = \frac{1}{1 + e^{-x}}, \quad (3)$$

$$f(x) = \max(0, x). \quad (4)$$

For the above formula, where formula (2) represents the tanh activation function, in the tanh activation function, it is obvious to see that the function is an odd function, setting its value range between negative infinity and positive infinity, but according to the definition of the formula for the function: in the function which can take all the output values of the input in the range between [-1, 1] and the function as an activation function, it can not only realize the nonlinear change of the neural network but also the function curve

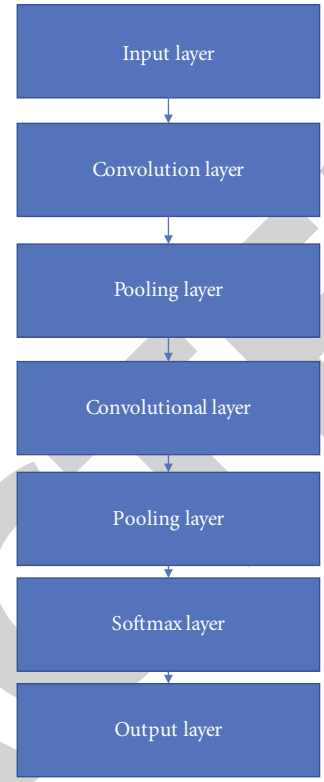

Figure 3: Basic structure of CNN network.

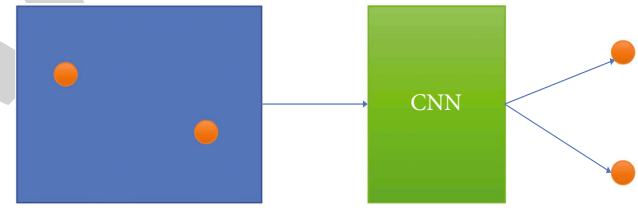

Figure 4: Abstraction of ECG abnormality recognition prediction under CNN network.

is smooth and can be derived at every point; so, it can solve certain convergence problems by applying this function to the neural network as an activation function. For Equation (3), it is a specific formula for the sigmoid function. According to the mathematically relevant theory, it can be found that the output values of this function range between (0, 1), i.e., all the output values are integers. Sigmoid activation function and tanh function, the same smooth curve, and any point in the x value can be derived. However, compared to the tanh function, the mean value of the sigmoid function is not 0, and both are prone to the problem of gradient disappearance. The characteristics of their functions will cause the convergence of the neural network to become slow, which is very unfavorable for the medical field in the need for emergency treatment of patients to know certain diagnostic conditions to carry out treatment; so, in this paper, it is not recommended to use the above two functions as the activation function of this paper.

For Equation (4), the mathematical formula for the ReLU activation function is expressed. The Chinese name

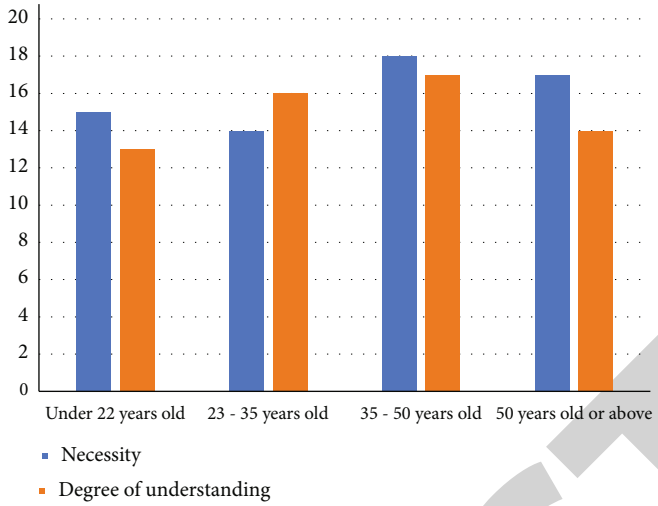

Figure 5: Survey on the necessity and knowledge of ECG examination among different target audiences.

is linear rectification activation function, which is a kind of activation function commonly used in deep neural network models. For the ReLU function, it can be described in two parts: one for the case greater than 0 and one for the case less than 0, where the x value is less than 0, and the output of the ReLU function is 0; at x values greater than 0, the output of the activation function is the input. By looking at the formula in (4), we can see that the activation function does not have a saturation zone like the sigmoid function, which means that it can better overcome the gradient disappearance problem brought by the sigmoid function and tanh function, because due to the characteristics of the function, the gradient is set to 1 in the part greater than 0; so, it effectively has the ability to solve the problem brought by formula (2) and formula (3). The problem of missing gradient is effectively solved by Equation (4). In addition, the activation value of the ReLU function is simple to calculate, and only a reasonable threshold is needed to get the appropriate activation value, which can simplify the problem of calculating the exponential level of the formula like Eq. (2). More importantly, the ReLU function has faster convergence speed and operation speed than the above two functions; so for this paper, the ReLU function will be used as the activation function of this deep neural network.

The basic model of the neurons of the deep neural network and the activation function used in this paper are described above, and by comparing the advantages and disadvantages of the three different activation functions, it is finally decided to use the ReLU function as the activation function of the deep neural network in this paper. And in order to get the results of ECG abnormality recognition prediction, this paper decided to use CNN neural network as the basic training model of this paper after comparing different neural network models under deep learning, where the specific block diagram is shown in Figure 3.

From Figure 3, it can be seen that the basic model of CNN neural network implemented in this paper for ECG abnormality recognition and prediction can be composed of two convolutional layers, two pooling layers, one output layer, one input layer and one output layer, and one softmax

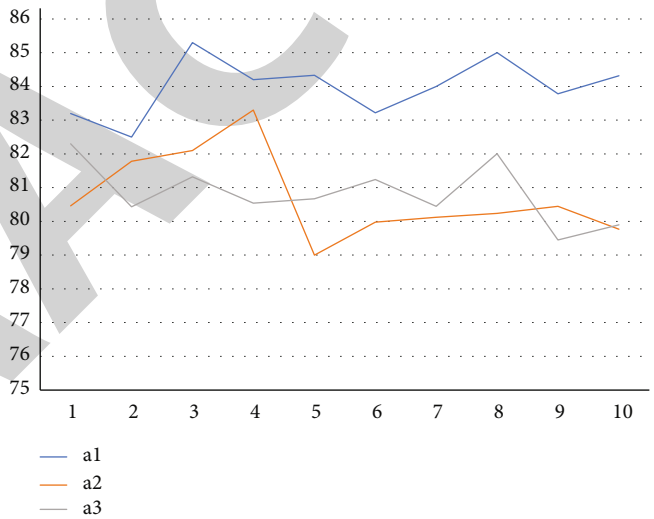

Figure 6: Accuracy curve of ECG abnormality recognition under different learning rates.

layer. The main function of the pooling layer is to process the high-dimensional features of the ECG obtained from the convolutional layer from high-dimensional to low-dimensional directions, while the convolutional layer is used to extract many high-dimensional features from the ECG by making full use of the convolutional operation and transfer them to the pooling layer in a suitable format for pooling. In this paper, the proper setup and processing of the convolutional operation is one of the key factors for the correct prediction of ECG abnormalities. For a more visual description of the CNN network, the recognition classification results of CNN can be viewed as shown in Figure 4.

As can be seen from Figure 4, the box on the left can be abstractly understood as the ECG situation of a certain examinee, and it is not known whether there is any abnormality in the heart when the ECG examination is performed. The two orange dots indicate that there is a certain problem with the heart of the subject, and further examination is

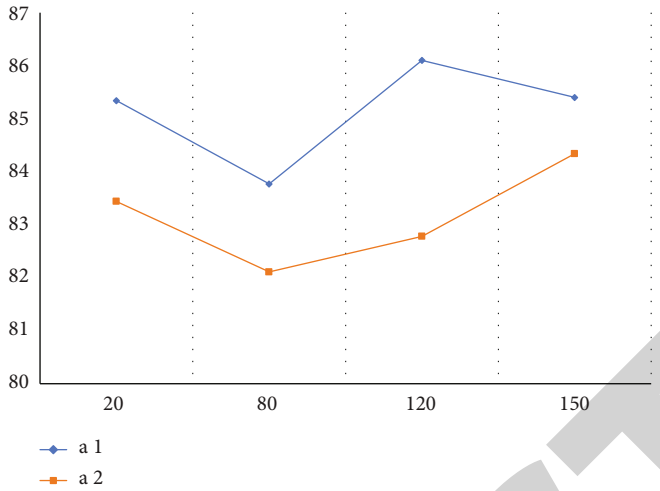

Figure 7: Accuracy curves for different batch sizes.

needed to determine what the problem is again. Figure 4 is an abstract diagram of ECG abnormality identification prediction under deep learning in this paper. The rightmost dot in the diagram means that there is some problem in the heart of the subject.

4.2. Collation and Analysis of Simulation Results and Research Results. After the above discussion and some training of the CNN network model in this paper, a neural network model applicable to the ECG recognition prediction in this paper was obtained. In summary, in order to improve the accuracy of this paper in ECG abnormality recognition, and to achieve the purpose of this paper from both subjective and objective aspects, the simulation results and related research results of this paper are now organized and analyzed. In order to highlight the significance and importance of this paper for the awareness of different target groups for ECG examination, a questionnaire survey was conducted for different age groups for this purpose, and a subjective survey was conducted for the elderly group who are less likely to use cell phones using a questionnaire survey. The results of the survey regarding the basic awareness of ECG and whether it is necessary to conduct ECG examination all year round are shown in Figure 5.

As can be seen from Figure 5, a questionnaire survey on the basic knowledge of ECG and the necessity of regular ECG examination was conducted for different age groups and offline questionnaires. The above survey data showed that the survey was divided into five age groups: under 22 years of age, between 23 and 35 years of age, between 35 and 50 years of age, and over 50 years of age, with a total of 20 people in each age group. The above data show that the greatest number of people agreed on the need for ECG screening between 35 and 50 years of age, and the least number agreed between 23 and 35 years of age; again, the greatest number of people agreed on the need for ECG screening between 35 and 50 years of age, but the least number agreed on the need for ECG screening was under 22 years of age. Thus, it is clear that the regularity of ECG screening and the level of knowledge about it are related to different age

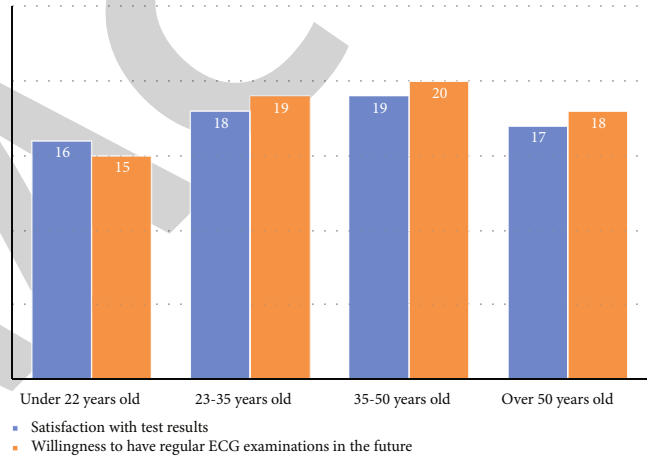

Figure 8: Survey on satisfaction with ECG survey, etc.

groups. Based on the above results, this paper uses CNN deep neural network to conduct this free ECG examination for the above respondents, and after the examination, they are sent to the deep learning network model for training.

From Figure 6, when the batch size is set to 80, the learning rate of a1 is 0.0001, a2 is 0.00001, and a3 is 0.000001. By observing Figure 6, we can get that when the learning rate is at the value of a1, the accuracy of the training of the model is the highest, the average accuracy can reach about 84%, the lowest accuracy is the a2 curve, the accuracy of this curve fluctuates to a large extent, and the average accuracy is only about 80%. In order to make the model reach the optimal value, the accuracy was also tested for different batch size, and the results are shown in Figure 7.

As can be seen from Figure 7, the horizontal coordinates represent different batch sizes with values of 20, 80, 120, and 150, respectively. First, fixing the data at the batch size of 120, we can get that the accuracy rate of a1 curve reaches 86%, which is higher than the accuracy rate when the batch size is other values; for a2 curve, we can find that the highest accuracy rate is 84% only when the batch size is 150; fixing the vertical coordinate, we can find that no matter what

the value of the accuracy of the a1 curve is, it is higher than that of the a2 curve regardless of the value of batch size, which is about 1.5% higher. It can be seen that the accuracy of the neural network model is the highest when the batch size is 120, and the learning rate is a1, i.e., 0.0001. Meanwhile, in order to more fully demonstrate the comprehensiveness of this paper's research and consider the spirit of human-centered concept, a survey on the satisfaction after ECG examination was conducted for the abovementioned people of different ages, of which the results are shown in Figure 8.

As can be seen from Figure 8, the number of people surveyed was the same as the number of people surveyed above, with 20 people in each age group. The reason for this difference is that most of the people who had heart problems during the ECG examination were between 35 and 50 years old, while the younger age group thought that it is also too early to have regular ECG examinations. The age group that is more willing to have regular ECG examinations in the future is between the ages of 35 and 50 years, which shows the importance of health issues in our country, while other age groups are not resistant to have regular ECG examinations, which fully shows the willingness of different age groups to have regular health examinations in our country.

5. Conclusion

The prediction and analysis of ECG abnormality identification can provide people with a more comprehensive understanding of their health and is also a sign of responsibility for their own life safety. The identification of ECG abnormality is an important way to determine whether the heart is healthy or not, and the subsequent prediction of the heart is also an important initiative for human health. In this paper, we firstly analyze the impact of urbanization and stress on people's health and even heart, then elaborate different ways of heart examination and related indexes, and complete the construction and training of CNN neural network model by starting from the theory of deep learning, and the final experimental results show that ECG examination is self-evident for people's health. The final experimental results show that ECG examination is a commonplace for people's health, and the CNN-ECG abnormality recognition prediction network model proposed in this paper has a high accuracy rate in ECG processing and analysis.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares no conflicts of interest regarding this work.

Acknowledgments

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Retraction

Retracted: Analysis of Human Resource Allocation Scheme for Digital Media Big Data Based on Recurrent Neural Network Model

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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Research Article

Analysis of Human Resource Allocation Scheme for Digital Media Big Data Based on Recurrent Neural Network Model

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At present, all kinds of computing models used in human society are based on statistics. Due to the large amount of data, conventional statistical methods cannot solve these problems well. In view of the concealment of data, the processing of large data plays a great role in the rational allocation of human resources, training professional talents, improving the operation of human resources, and improving the use and efficiency of human resources. This paper combines the method of human resource allocation based on recurrent neural network and conventional human resource allocation, in order to find a suitable method for personnel position selection and recommendation in the field of talent work. In terms of algorithm test, the F1 value of the proposed method is 0.823, which is 20.1% and 7.4% higher than the previous two methods, respectively, indicating that the method can effectively improve the hidden features, improve the training effect, and improve the performance of the model.

1. Introduction

In the big data of digital media, the rapid development of artificial intelligence technology makes the intelligent process of human capital management of enterprises develop rapidly. At present, in the enterprise, more and more companies begin to pay attention to the intelligent personnel allocation.

Using the digital media data based on recurrent neural network, the rational human resource allocation strategy of enterprises is studied, which is helpful to effectively train professionals in various industries, optimize the operation mode of enterprises, and improve the resource utilization rate of enterprises [1]. In the process of promoting enterprise integration, the economic and social benefits of the company are better realized, so how to effectively implement the intelligent management of human capital has become a very critical issue [2]. Fundamentally, the most prominent feature of the intelligent society is the explosive increase of data, which makes it difficult for the previous HRM methods to adapt to the large-scale data demand. It is impossible for simple traditional HRM to realize that effective decision-making for people analyzes and transfers a large amount of resources, resulting in a large amount of data being used [3]. This not only makes the company lose a lot of information, but also hinders the development of information technology. Therefore, the advanced intelligent computing method is introduced into the HR system, which can greatly improve its HR processing [4].

The essence of data processing is to extract data effectively by means of software. In the past data mining, the statistical method is generally used. In the case of insufficient data, the statistical method can be used, but in the case of quantitative and incremental, this method cannot meet the needs. Machine learning is a very useful data mining technology, which can train a large number of data, extract some hidden features from the data, and through continuous research, achieve accurate extraction of data. Machine learning technology is used to process human resources, and cyclic neural network technology is used to study a large number of digital media in order to further improve the processing efficiency [5].

2. Research Background

The various computational models currently used in human society are based on statistics. Due to the large amount of data, conventional statistical methods cannot solve these problems well. In view of the concealment of data, the processing of large data plays a great role in the rational allocation of human resources, training professional talents, improving the operation of human resources, and improving the use efficiency of human resources. This paper combines the method of human resource allocation based on recurrent neural network and conventional human resource allocation, in order to find a suitable method for personnel position selection and recommendation in the field of talent work. In terms of algorithm test, the F1 value of the proposed method is 0.823, which is 20.1% and 7.4% higher than the previous two methods, respectively, indicating that the method can effectively improve the hidden features, improve the training effect, and improve the performance of the model [6].

3. Materials and Methods

3.1. Traditional Human Resource Allocation Model and Recurrent Neural Network Human Resource Allocation Model. According to the theory of human resource allocation in the historical sense, human resource planning is mainly to sort out the human resources of enterprises in detail. Human resource allocation has multiple components, which are weighted and added together to determine the quality score of human resources, and the results are recommended according to the calculated indicators, as shown in Figure 1.

First of all, the received data are classified into personnel evaluation and personnel quality. The most commonly used evaluation method is to establish an employee evaluation model, including employee self-evaluation, superior evaluation, and other factors. The performance quality model of employees includes indicators such as employee performance, attendance rate, and rank [7]. Based on the evaluation of employees and the analysis of their skills, the matching degree between the company's main personnel and their positions is obtained as follows:

$$H_{ij} = n_1 a_{ij} + n_2 b_{ij} + \cdots + n_4 d_{ij}, \tag{1}$$

where n_1-n_4 is the corresponding evaluation parameter, so the personnel is optimized according to the person-post matching degree model, as shown in:

$$\sum_{i=1}^{n} \sum_{j=1}^{m} s_{ij} X_{ij}. \tag{2}$$

The traditional algorithm can optimize the allocation of human resources in a simple and effective way, which is only applicable to the case of less human data. With the development of enterprise system, human data is also increasing and the problem is becoming complicated. The calculation of recurrent neural network is more efficient compared with the traditional method, and it can be good for mining and processing data at the big data level to enhance the effective management of human resources.

3.2. Improving the Recurrent Neural Network Model. In this paper, we believe that the essence of HRM model is to achieve human resource allocation by counting human resources and matching them with jobs. Basically, it can be abstracted into a recommended model. In many aspects, the recommendation model has been studied and demonstrated, and the current mainstream recommendation models all use algorithms based on recurrent neural networks. Its most important feature is the use of recurrent neural networks for data learning, which can be viewed as a hierarchical profile with raw information from humans as input, and then different information is extracted from different perspectives through the steps of recurrent neural networks such as computing, pooling, and activation [8].

3.3. Algorithm Flow. The algorithm process is manual post-matching, and its process is chosen according to the actual situation and data characteristics [9]. The current method used in human resources is based on statistics, which easily leads to a lack of information due to the lack of analysis of the implicit characteristics of the data and the pure reliance on simple scoring methods and expert judgments. Based on this, a new algorithm based on recurrent neural network is proposed. The key to this method is to extract from the data the basic attributes that have the ability to match traditional talent requirements, such as human capital evaluation and human capital quality matrix. The collected data is imported into a coding machine, and the obtained information is fed to the data input stage of the recurrent neural network as the input to the data [10]. The algorithm flow is shown in Figure 2.

First, data acquisition is performed, which uses a distributed streaming acquisition method for data selection, grouped into a personnel evaluation matrix and a personnel competency matrix. The information was abstracted and preset and then decoded and stored in the data warehouse using the coding machine; the data was reinforced using the method of increasing the amount of features. Finally, it was fed into the recurrent neural network and output to the score of person-job matching, thus realizing the recommendation of talents, the steps in the algorithm flow are explained as follows [11]:

(1) *Collecting data.* Using the data collection method of distribution flow, the format varies due to the differences in manpower data from different companies. Therefore, the manpower data must be processed in a uniform format, and the processing includes operations such as data rounding and conversion. After the data is cleaned, converted and aggregated, the data is reorganized as needed, stored in the data storage system, and then input to the Web proxy server [12].

(2) *Preprocessing the initial information.* This information is categorized for a more complete explanation of the characteristics of human resource allocation. And storing this information in a repository to support later information modeling. Data processing: first preprocessing the collected data, e.g., filling in

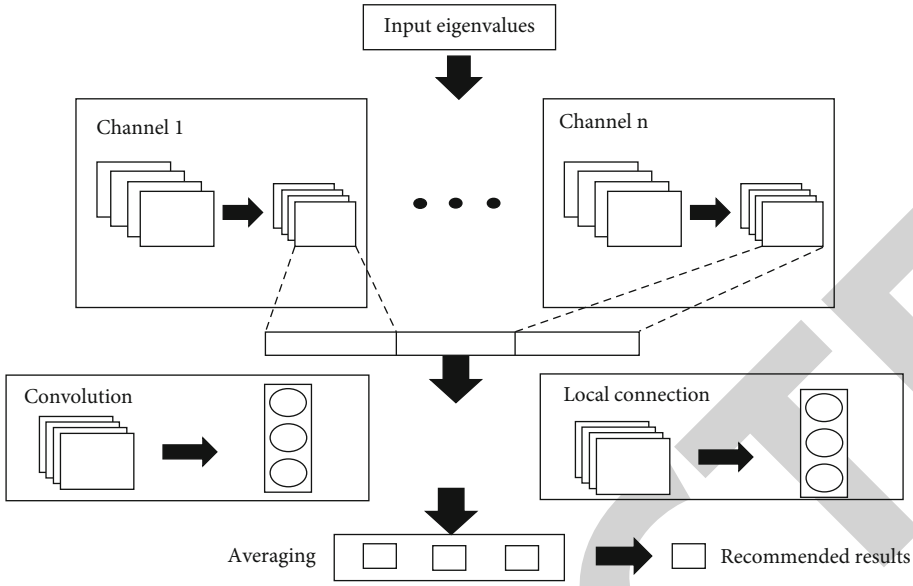

Figure 1: Flow chart of recommendation results.

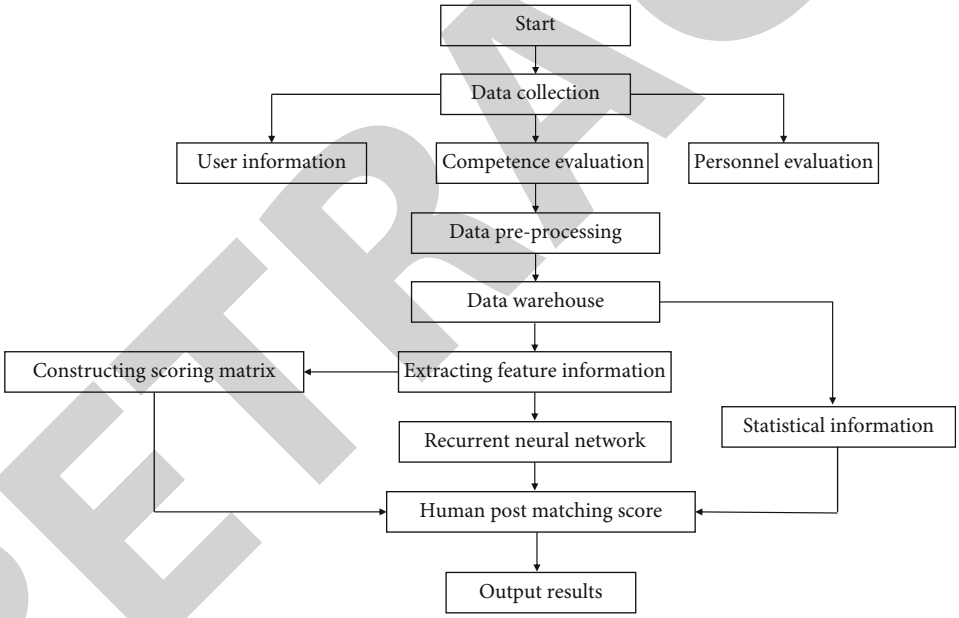

Figure 2: Algorithm flow.

omissions, and then dividing the data into two categories, training and testing, respectively [13].

(3) *Implementation of feature enhancement.* Information is extracted from the database and classified. The method is learned by performing an artificial neural network on the obtained information. Based on this, the model is introduced into a multilevel neural network for learning, and while learning, an adaptive moment estimation algorithm is used to implement parameter updates of the system

(4) *Recommendation result output.* The human-job matching degree results are ranked, and then the reasonable job assignment is made with reference to the scores. In addition, the target data is calculated accordingly through the feature algorithm model to generate the result data, and then the result data is presented to the end user through the data output module [14].

3.4. Algorithm Evaluation Index and Digital Media for Human Resource Allocation. For a new algorithm, it is usually evaluated by a specific index, and on this basis, an evaluation method based on accuracy is proposed. In the evaluation system, higher accuracy and higher recall are preferable. However, in some cases, there is a contradiction between accuracy and recall ratio, so the values of F1 are combined.

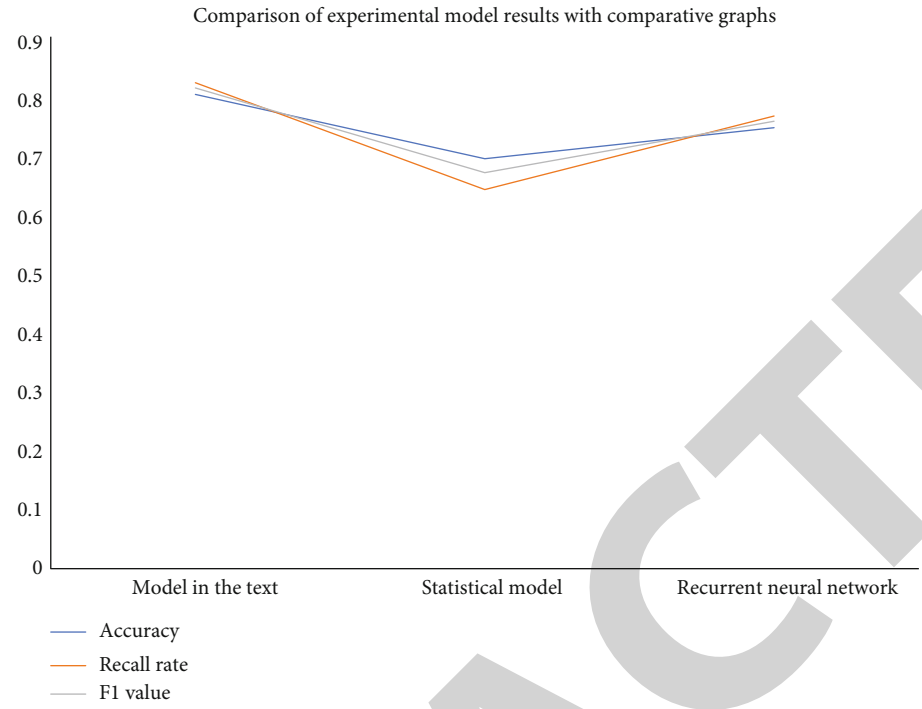

Figure 3: Comparison experimental model results comparison chart.

In the industrialized era, it is an era centered on machinery and money, while in the information era, it is an era centered on media and information. The development of the digital economy and the Internet is synchronized. Analyzed from the viewpoint of development forces, it is mainly driven by the network and data, that is, the two major driving forces based on network communication technology, transmission technology and data computing [15].

Using these two methods, it is possible to categorize a variety of complex materials [16]. Digital content and data are the key elements of the contemporary media industry, which is represented by media, content, and data as the main content and the basis of digital media [17]. However, the current digital media industry is still dominated by the Internet, and with the development of computer technology, the promotion of data will be the driving force behind the development of data, and this development will be gradually reflected in new media such as big data and other new media [18].

3.5. Experimental Data as Well as Environmental Description. The data in the paper are categorized for corporate HR data, and the data contain comparative experimental model results compared to the graphs of the environment of that experiment, as shown in Figure 3.

4. Results and Discussion

4.1. Actors' Networked Vision of HR: Prospects and Difficulties. Driven by the wave of digitalization, human capital management theories and scientific research activities of companies have been newly developed, but business managers and researchers also have to face how to effectively use digital media big data to promote the development of companies. This paper presents a comprehensive view of the application of digital technology in HRM from the perspective of human interaction. From the relationship between "people" and "technology," this paper summarizes the new approaches and new business environment brought by "digital technology," and analyzes the business in terms of cognition, emotional experience, adaptation, and resistance. We also analyze the company from the aspects of cognition, emotional experience, adaptation, and resistance.

Today, with the development of digital technology, machines are becoming more intelligent and have become similar to human beings in appearance and interaction. Whether it is intelligent customer service online, robots in shopping malls, hospitals, banks, or machine learning computing with superior computing power, digital technology is to some extent like human beings [19]. Given the concept of actor networks, which recognizes the proactive, performative nature of technology, the meaningful equivalence of technology and humans, and sees technology as an equal object that interacts with humans, the next section also discusses how to respond to these issues on this basis in the cooperation of employee and machine intelligence. In this paper, the model is classified and divided into two groups: training and testing. In the detection phase of the recurrent neural network, for example, the hyperparameters are initialized with parameters t, the learning rate L, and the hyperparameters $\beta 1$ and $\beta 2$ of the recurrent neural network, whose operational gradient gt to $i = t$ is the end point.

Simulation tests of the algorithm, recurrent neural network, and traditional statistical methods in the paper were conducted and the correctness, recall, and F1 values of the algorithm were verified through experiments, as shown in Figure 4.

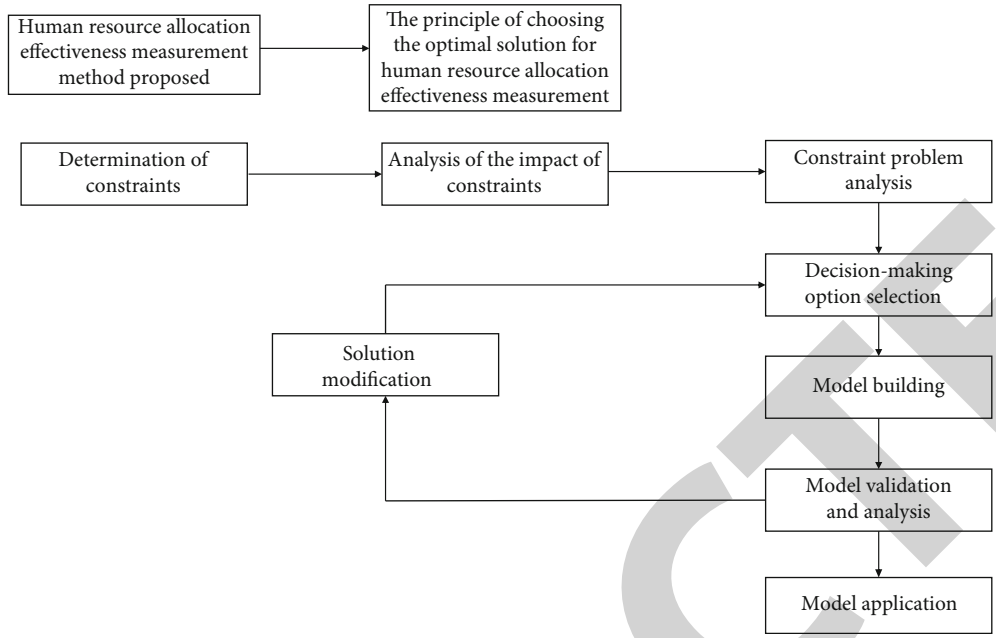

Figure 4: Survey chart of human resource allocation system.

4.2. Dimensions of Digital Media Big Data. There are two driving dimensions of the digital economy with different advantages and disadvantages. Therefore, the result of various combinations is different economic forms. Compared with traditional industries, such as IT consultant and ICT equipment industry, both net and data-driven are lower in status; high net-driven but data-deficient is represented by digital media industry. Today's media industry relies on network communication technology and relies on big data computing to achieve scale benefits that have not yet emerged. However, in the near future, intelligent media will rely more and more on data computing. The IT software industry is an industry powered by high data but powered by the low-speed Internet. In the digital era, the industry with telling network and data is the most dynamic industry [20]. At present, the industries oriented by high speed internet and information include the emerging smart economy, big data industry, platform economy, cloud computing service industry, and internet finance. From the perspective of industry development, this paper argues that the innovation of digital economy includes both Internet and data, i.e., more new industrial forms will be generated in the application of intelligent technology.

Digital media is such a community of human interaction, it combines communication media content and data in one. In the digital economy, all media are digital. With the impetus of ICT, media forms are bound to go through a process of continuous innovation. The future trend is undoubtedly visualization, intelligence, and even integration and simulation expansion with human organs. In this way, the integration of the human body and media terminals is the result of the digitization of content production, the ultimate direction of the integration of media and network platforms. The communication hub between humans and the world is the intelligent network, and in big data, inexhaustible media products will naturally arise to meet the various needs of humans.

With the continuous development of digital technology, the use and operation of digital technology in the corporate world has encountered many problems. On the one hand, it has shifted its target from within the enterprise to the highly centralized personnel with highly intelligent digital technology and digital technology. However, current HRM theories do not fully affirm the positive impact of digital technology on the development of companies, and at the same time raise questions on matters such as training satisfaction of personnel within companies will decrease, training costs will decrease, work motivation will be affected, and the departure of employees will also be affected. It has to be said that many organizations are experiencing a "disillusionment" with the digital concept under the impact of digital technology. Against this backdrop, there is an urgent need to organize and align with the new digital practices that are emerging.

According to some scholars, the unsatisfactory aspects are mainly due to the practice patterns of digital technology in human resources management that do not meet the human conditions, the one-way communication between managers and the managed, and the digital distance between the organization and the individual brought about by digital technology. Practitioners are constantly calling for the training of employees in digital technology integration skills. However, it is undeniable that the relationship and integration between digital technology and individual employees has not yet been given sufficient attention by academia. In the current field of organizational management, especially human resource management, many digital reviews still fall on the one-way impact of technology on employees, and do not sort out and summarize the attitudes of employees towards digital technology and the connection between employees and digital technology. Since there is little

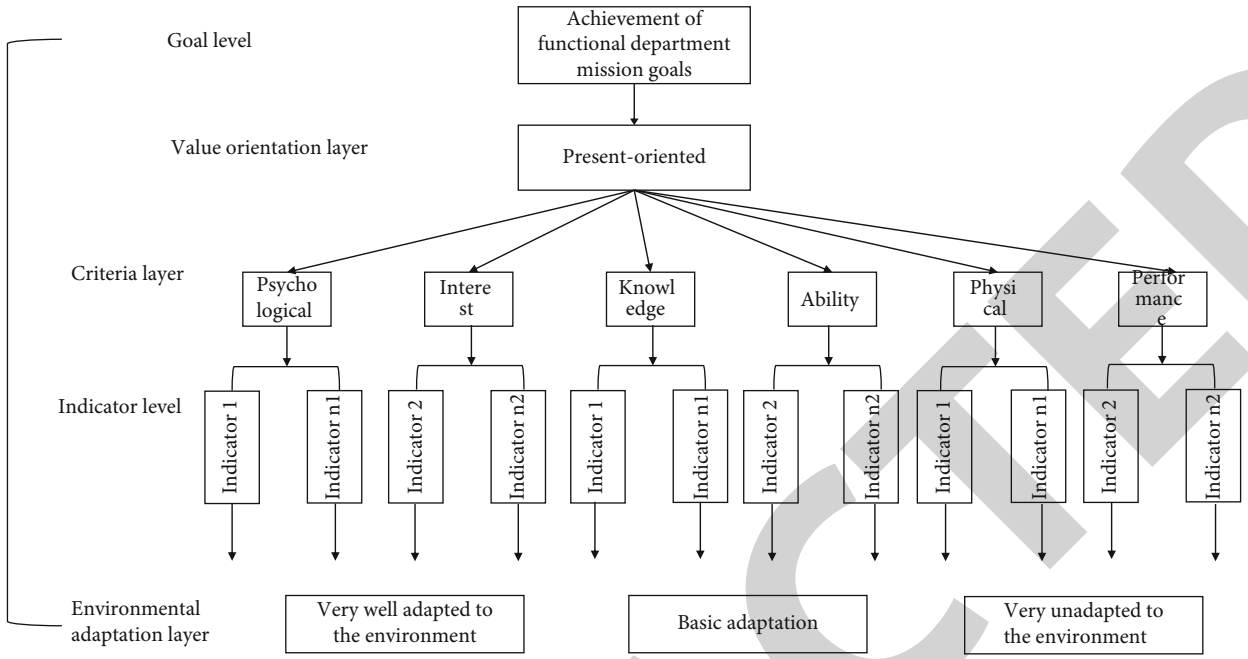

Figure 5: Intelligent departmental task hierarchy analysis diagram.

literature available, this thesis focuses on the link between technology and people, viewing digital technology as a link between people and technology and organizing its latest developments in a more comprehensive manner. Based on this, the thesis provides an overview of both structural and behavioral aspects to explore how employees recognize, experience, and adapt to digital technology in HRM, and summarizes the important issues faced by managers when facing a human-machine collaborative hybrid organization to address the challenges and difficulties of new HRM practices in the digital age, as shown in Figure 5.

4.3. Application Example Analysis of the Research Object. The quality of employees within an enterprise determines the level of the actual output capacity of the human resources of the enterprise. Through factors such as work ability, work attitude, organizational factors, and work environment factors affect their work performance. The external conditions of work behavior are constant within and outside the enterprise; different work attitudes and abilities characterize individual human resources; labor is a labor with procedural nature. Under the influence of external environment, the way of labor and labor functions change. In a certain external environment, the quality of employees is an important indicator that determines the final production performance of the enterprise. Under certain external conditions, the quality of employees is a key factor influencing the final performance of the enterprise. In an enterprise, the quality of employees also has a great influence. It also has an impact on the actual output performance of employees to some extent. In different companies, the human resource characteristics of the company can also have a great impact on the behavior of employees, which can lead to differences in employee performance.

The individual productive effectiveness of individual individuals in their respective unrelated functional areas differs to some extent from the individual human capital structure. If the prerequisites for the use of labor or the application of core technologies are met, the productivity of the company's human capital is the key factor affecting the productivity of the company. In this case, the characteristics of human capital have an impact on the actual production capacity of the individual. When using talent based on experience, skills, and knowledge, the focus is on teamwork. In this case, the characteristics of talent have a significant impact on the mix of talent, as shown in Figure 6.

The quality of people within the company determines the actual level of production of human capital. Through factors such as work ability, work attitude, organizational factors, and work conditions have a role in the performance of employees. The external conditions of work behavior are the internal organization and internal environment of the enterprise, both of which are invariant; the difference between work mentality and work skills is a reflection of the individual's human capital characteristics; the work of the job is a work of a procedural nature, which, when determined by external conditions, is subject to change by the work style of the job and the work ability. Therefore, under given external conditions, the characteristics of human resources are the key factors that affect the actual output capacity of human resources. In a certain external environment, the quality of the company's employees is an important indicator that determines the final production performance of the company. In turn, the quality of an enterprise's employees is an important factor in the enterprise. And it has a certain influence on the actual output performance of the enterprise's employees. In different types of enterprises, the human capital characteristics of the enterprise also have an impact on the role of the

Figure 6: Schematic representation of factors influencing job performance.

enterprise's employees, which in turn produces different performance.

For different types of functions, the characteristics of human resources have different effects on the actual output capacity of individual human resources and the relationship between the combination of human resources. When the manufacturing industry uses human resources based on physical strength or basic skills, the actual output capacity of individual human resources plays an important role. In this case, the characteristics of human resources mainly play a role in the actual output capacity of individual human resources. When using human resources based on experience, technology, and knowledge, teamwork is emphasized and the human resources portfolio relationship plays an important role. In this case, human resource characteristics mainly play a role in the human resource portfolio relationship.

4.4. System Process. The characteristics of people within a company are explored in depth. The talent characteristics of the enterprise are discussed from multiple perspectives. In this paper, the characteristics of the talent of the enterprise are explored from multiple perspectives. Human biology, temporality, recoverability, value, and autonomy are the basic characteristics of human beings, with the characteristics of mobility, value-added, social, control, noncontrol, etc. The analysis summarizes the characteristics of human resources as follows.

(1) *Biological Differences*. The human being is a "living" substance, which is closely linked to the essential characteristics of the human being. There are limits to the resources (energy, time, space, etc.) available to a living being, and there are limits to the resources

(2) *Temporality*. There is a certain time frame for the formation, development and utilization of talents. People are people who work for a limited period of time in their lives and work for various periods of time (adolescence, prime age, old age). They also work at different intensities

(3) *Recoverability*. Human resources are recoverable and renewable resources. Individual human resource resilience is achieved through the process of labor reproduction. This process consists of human forces, natural forces of nature, and "social labor" (the forces of labor relations between people). This process of interaction of external and internal variables is a combination of natural and social properties of human beings

(4) *Value*. In the process of formation and development, human resources necessarily generate a certain investment, and its value is reflected in the price of labor under the action of the market

(5) *Autonomy*. The worker is a worker with thoughts, feelings, will, personality, and creativity that the material elements do not possess. By discovering problems in production activities, accumulating experience, creating and improving labor materials, discovering, and transforming and using new forms of labor, workers promote the development of productive forces. In production activities, workers not only use various resources passively but also can make full use of resources by rationalizing the structure of labor force

(6) *Value-addedness*. When labor substances are used, they are made to give full play to their role in labor objects so that they have a role beyond their own. In terms of labor consumption, it can be compensated by income from the sale of goods and services, or by value-added. It can be compensated either by the sale of products and the income from services, or by the increase in value

Taking human resource managers of DT enterprises as the research object, a general model is constructed by combining behavioral surveys and questionnaires to make a comprehensive evaluation of managers' abilities and qualities. After preliminary data analysis and data extraction, classification, categorization, and coding were conducted, and interviews were conducted with general employees and excellent employees. Based on the classification of expertise, knowledge, and skills, a competency and quality evaluation model for managers of enterprises was constructed. DT classified the positions according to each level and weight of the skill quality model and made a corresponding job qualification table, labeled with the indexes corresponding to each level to facilitate benchmarking.

On this basis, in accordance with the requirements of professional qualifications, expert assessment and three questionnaires were used to assess the job competencies of the company's personnel manager, professional engineer, and skilled operator to evaluate their suitability with the job, and I made the scores. Mismatched individuals required targeted training, especially those with low indicators of specific competencies and qualities.

(1) *Recruitment Selection*. During the recruitment and selection process, DT uses the staffing model as the basis for a thorough assessment of the candidate's key competencies and their fit with the job requirements. To help interviewers focus on the key competency indicators for the position, a competency-based selection process can be used to form unified evaluation criteria, establish standardized competency indicators, and allow interviewers to make consistent judgments, making the interview process more systematic

(2) The company evaluates the personnel of each unit based on the staffing model and issues an organizational and individual personnel analysis report for each unit. On the basis of the assessment report, we identify the shortcomings of staff capabilities, analyze training needs, develop reasonable, systematic, and scientific training programs for capability enhancement, and invite experts to provide targeted training to staff to effectively improve the company's management level and staff quality

(3) *Performance Evaluation*. DT incorporates competency and quality assessment into its performance evaluation system and combines it with performance rewards. Performance appraisal standards are set not only to determine indicators of competence and quality development, but also to determine job performance indicators based on employee development and contributions to the company, by appropriately matching long-term and short-term performance with current values and the company's long-term development needs to ensure high quality and quality work

(4) *Incentives for Outstanding Employees*. DT has gradually developed an excellent employee selection mechanism based on the recurrent neural network algorithm model. Competence quality evaluation and performance evaluation are the conditions for the participation of excellent employees. Employees with high performance and competence evaluation must participate in the selection of excellent employees, and the higher their performance, the more advantageous they are. From the perspective of DT New Energy Power Generation Company, establishing a staffing model that links employee competencies to the company's strategic goals will ensure the efficiency of the company's strategy implementation. At the same time, based on the quality of competencies, the best talents will be invested in the company to create greater profits, improve the company's core competitiveness, and lay a solid foundation for winning in the competition. From the perspective of the employees of DT New Energy Power Generation Company, through the talent matching model, employees clearly recognize their own shortcomings and strengths and improve their expertise and core competitiveness in various ways. On this basis, supervisors can communicate with employees to continuously improve their performance and support their future learning and development plans

The core idea of the model is to achieve a rational allocation of employees by counting human resource information within the company and matching it accordingly. Based on the basic neural network, a hybrid recurrent neural network model, a global model, and a local model based on neural network are introduced to transform the results of the hierarchical operation of the model into the output of the network, and then the model construction of the hierarchical model is used to construct the network so as to achieve a high accuracy rate of talent allocation and recommendation.

From the perspective of working time changes, we can see that four-day working time is adopted by many countries, and companies often set the direction and goals for the new year and create more new jobs at a specific time of the year. In addition to daily operations, HR should pay more attention to the changes of talent flow and allocation, focus on new areas that can create more value for business, and actively search, identify, and create value. Facing the changes of digital economy, enterprises are increasingly focusing on innovation capacity building and organizational capability improvement.

Over the past hundred years, the management mode of Chinese enterprises has changed from mechanized, moderately humanized, and highly humanized, to autonomous management; from the assumption of "economic man" to "social man" to today's "self-made man" and "composite man"; from the initial "man is a machine" and "Tyro system" to today's increasingly important personal needs, personality, and desires of the transformation of business

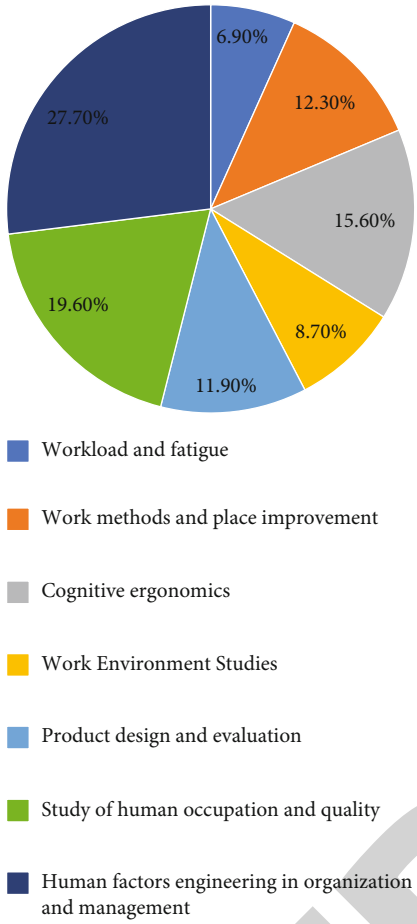

Figure 7: Comparison chart of corner point detection effect.

management philosophy. It is thought-provoking that HR management, now driven by digital technology, now seems to be "bucking the trend": increasingly advanced digital technology, increasingly precise, comprehensive, quantitative and dehumanizing talent control, and an increasingly unbalanced power gap between companies and employees, as if pushing humanity back into a new era. However, in the era of the rise of personal values, employees with a stronger sense of self and higher motivation for achievement, the pursuit of individuality, personality, and self-actualization are in conflict with the HRM approach of quantity, efficiency, and precision, as shown in Figure 7.

In addition, due to the introduction of mechanical intelligence, the work and learning habits of people within the company have changed, which has a great impact on the design of work and jobs in the company. The results of this study tell us that in order for machines to better master them and build their own winning capabilities, it is necessary to find suitable alternative methods. Perhaps in collaboration with AI, these new practices will be explored in the traditional HRM domain of job design and learning behavior. As shown in Figure 8.

Digital technology-based talent profiling has led to a greater focus on accuracy, comprehensiveness, and predictability in the training and development of employees. This approach has facilitated the operation of human capital in

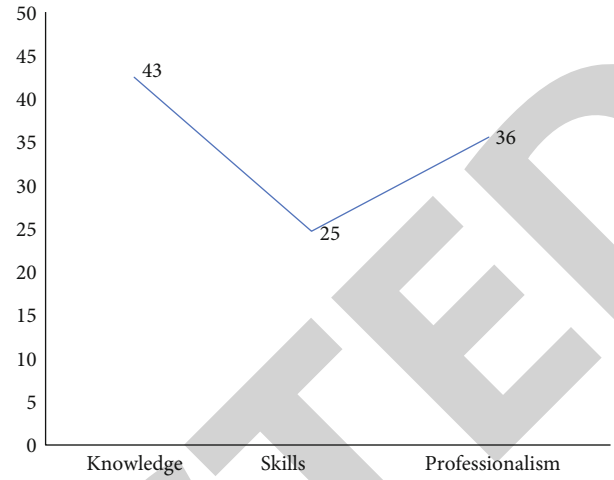

Figure 8: Training data analysis graph.

companies to some extent, but to some extent there are also problems that limit the motivation, proactiveness, and creative autonomy of people within the company to make decisions. In today's companies, the value of individuals is constantly growing, and the new generation of employees is highly self-aware and has a great drive to succeed. How to resolve the tension between the objective and quantitative organizational HR management model and the subjective and diversified individual value demands of employees, help employees "grow freely", and provide them with appropriate guidance and intervention, so as to achieve the efficient performance of a diversified organization. Although digital technology has had a significant impact on human resource management in companies, experts have pointed out that the efficiency of human resource management in companies is not yet effective due to the use of digital technology. Therefore, it is important for researchers to reconceptualize digital HR from the perspective of employees. From the point of view of the relationship between humans and technology, the structural properties of technology are not static; they are created by humans for the use of technology, and therefore, the object nature of technology is of no value apart from the purpose and purposefulness of human action. To make digital technology more effective, it is necessary to stand in the perspective of the employee and pay attention to technology cognition, emotional experience, adaptation, and resistance.

5. Conclusion

Under the rapid development trend of digitalization and informatization, the role of human resource management has also undergone new changes, from traditional content providers to IP developers, and the operational structure has also changed from a relatively static one-way supply chain model to a continuous and dynamic diversified production model, bringing new impetus to product development in terms of content resources, added value and influence.

Based on the interaction between "people" and "technology", and based on the concepts of "structure" and "actor", we will provide a comprehensive analysis of the role of

"digital technology" in the development of "digital content". A comprehensive review of the application of "digital technology" to "human capital" is presented. Based on the principles of structuring, the paper presents new developments and new directions of digital technology and new work models from four perspectives: knowledge and skills, motivation and effort, employee engagement, and employee relations, and then organizes employees' cognition, emotional experience, adaptation, and resistance.

Under the actor network theory, this paper summarizes the advances in research on machine intelligence and human intelligence from three perspectives: trust and rejection, cooperation and adaptation, and cooperation patterns. Based on a review of existing research advances, this paper identifies the shortcomings of existing research. Research based on structural theory lacks attention and research on the tension between technology-induced structural changes and employee responses.

How do these two issues fit together from an integration perspective? Research on actor networks has focused on the coordination and alignment of machine intelligence with artificial intelligence, while lacking theoretical and empirical attention to their potential competitive relationships. Therefore, this paper focuses on the analysis of human resource allocation schemes for big data in digital media based on recurrent neural network models. This paper also presents new research and redefinition of the definition, categories, structure, and measurement methods of the digital economy, and attempts to construct a framework for human resource allocation at multiple levels. The paper also analyzes and evaluates the traditional statistical calculation methods currently in use and proposes directions for improvement. Based on the above perspectives, this paper presents the following two conclusions and outlooks.

First, it starts from the interaction between people and technology, and then explores how technology affects the talent practices of organizations and how it influences the behavior of organizations from the relationship between people and technology. This perspective not only compensates for the previous one-way approach to digital HR, but also provides a more comprehensive and systematic approach to the in-depth understanding of academia and practice. This paper argues that it will further explore the integration between digital technology and employees and propose a new way of measuring and metering based on a new measurement model. This is a historical stage of development, a stage of productivity development after the industrial age, where the next generation Internet, 5 G, big data, and artificial intelligence … all are still on the way, and the development of big data still has many problems to be explored and solved.

Second, in today's environment and context of organizational digitization, the concept of managerialism can be carried over into organizational practice when issues such as accuracy, practice effectiveness, and predictability are solved by digital technology. Future HRM research should be humanitarian in nature, respecting humanity and human dignity is not just an economic consideration, it integrates theoretical knowledge from different fields and challenges more complex and challenging management issues—what are the core values of employees and how can organizations build collaborative human-machine systems to improve the organization, while realizing employees' personal values.

Data Availability

The dataset is available upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Research Article

Machine Learning-Based Prediction Study of Hematoma Enlargement in Patients with Cerebral Hemorrhage

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The enlarged hematoma is closely related to the poor neurological prognosis of patients with cerebral hemorrhage (intracerebral hemorrhage, ICH). Therefore, it is of great clinical significance to accurately predict whether ICH patients. In this study, we explored the predictive ability of a two-model machine learning, machine learning (ML) method to predict hematoma expansion. This method features nonenhanced CT (noncontrast computed tomography, NCCT) in ICH patients. The image information is combined with multiple clinical data for the prediction of hematoma enlargement. We retrospectively collected 140 ICH patients (including 58 patients with hematoma enlargement) from our hospital in 2021, and obtained a total of 5616 NCCT hematoma images (including 2635 images of hematoma enlargement) and 10 clinical data for each patient. The dual-model ML method used in this study contains 2 steps. The first step is to use a single-model predictor based on deep convolutional neural network (DCNN), which uses only the patients. The baseline NCCT images were performed for the prediction of hematoma enlargement. To select an appropriate DCNN model, we simultaneously compared the prediction performance of the three DCNN models, including ResNet34 (residual neural network with 34 layers), VGGNet (visual geometry group network), and GoogLeNet (Google inception network). In this step, we also explored whether the method of hematoma segmentation could improve the prediction outcome. The second step is to use the dual-model predictor based on multilayer perception (MLP), where the results of the single-model predictor in step 1 are combined with multiple clinical data of the patient to predict the final result. The sensitivity, specificity, positive predictive value, and negative predictive value were calculated for each model, and were predicted using the subject operating characteristic curve (the receiver operating characteristic, ROC) and area under curve (AUC) to evaluate prediction performance. The experimental results show that the ML method proposed in this study can comprehensively analyze the patient NCCT image information and clinical data, which can achieve 86.5% accuracy and have relatively equal sensitivity and specificity. Therefore, this ML method can be used as a predictive tool to effectively identify people at high risk of hematoma expansion. This study can make an effective prediction of hematoma expansion in patients with clinical cerebral hemorrhage, which can better treat patients, improve the doctor-patient relationship, reduce complications, etc.

1. Introduction

Intracerebral hemorrhage (ICH) is a fatal neurological disease, which accounts for about 10% to 30% of all strokes. It is one of the most dangerous subtypes of stroke, with a mortality rate of 30% to 50% within 30 days, and more than 75% of patients may have residual disability or death after 1 year [1]. The enlarged hematoma volume expansion occurs in 30% of ICH patients, which is an independent predictor of poor late functional prognosis and a key prevention and treatment target in clinical work [2]. However, the use of CTA is limited by multiple factors, such as patients with renal function impairment and elderly patients with poor peripheral vascular conditions unable to receive contrast agent injection. In contrast, nonenhanced computed tomography sweeps as the preferred diagnosis method, noncontrast computed

tomography (NCCT) is widely used in clinical work. For the above reasons, the use of NCCT to predict hematoma expansion has attracted more and more attention and research [3].

The prediction of hematoma enlargement has attracted more and more attention and research. At present, several predicted signs based on NCCT have been proposed, including hematoma irregular shape, heterogeneous density, "mixed sign", "black hole sign" and "island sign". Although the above signs can be relatively high specificity, but its sensitivity is only about 50%, which causes the above signs is difficult to accurately identify the hematoma expansion of high risk patients and difficult to be applied in clinical work, and the above prediction signs identification is difficult, especially for inexperienced doctors and basic hospital doctors is particularly difficult, the reason is that the above signs or for the lack of comparison. To define it accurately or to define it as cumbersome is difficult to remember. For the above reasons, we need to consider whether there is an insufficient prediction using only imaging information. Moreover, in addition to the above presented above, some clinical data, such as the time from onset to baseline NCCT, hematoma volume on baseline NCCT have been confirmed to be closely related to hematoma enlargement. Therefore, in this study, we tried to predict the risk of hematoma enlargement in patients with cerebral hemorrhage with 1 two-model prediction method, namely, combining imaging and clinical data.

If we consider the prediction of hematoma expansion as a classification task, which is divided into two categories of hematoma expansion and the other that does not expand, then, machine learning (ML) technology is the most effective tool to complete such tasks. Multiple studies have confirmed that ML can achieve good results in disease identification as well as prediction, with very good performance. However, ML-based model training usually requires a large number of patients to train neural networks to achieve satisfactory results. For example, pulmonary nodules and diabetic visual networks were detected. Membrane lesions require thousands of samples. Collecting such a large number of patients will be a very time-consuming process, and the time spent collecting patients can take years [4].

For the limited number of patients, this study chose a two-model ML method, through which we can combine NCCT images and patient clinical data together to predict the expansion of the hematoma, which can achieve good classification prediction effect with relatively small samples. Previous studies have also adopted the research method of combining images with clinical data and achieved good results.

2. Progress of NCCT in Predicting Hematoma Expansion and AI Machine Learning

Approximately 30% of patients with CH will experience hematoma enlargement, which is an independent predictor of poor neurological outcome, and is also a therapeutic focus in clinical work. In clinical work, identify high-risk patients with possible hematoma expansion in the early stage, and give early targeted treatment is critical to improve the treatment effect and prognosis of patients with cerebral hemorrhage [5]. NCCT is the most basic diagnosis and treatment method to diagnose cerebral hemorrhage, which is widely used in hospitals of all regions and levels [6]. Thus, the search for imaging predictors of an enlarged ICH hematoma in NCCT has been ongoing since the 1780s. So far, multiple imaging signs have been associated with hematoma enlargement. Compared with CTA, NCCT is easy to apply and cheap. However, the prediction accuracy of signs in NCCT is low and subjective. Moreover, for clinicians, it is very difficult to correctly identify signs in images, and manual identification is subjective and time-consuming [7].

Artificial intelligence belongs to the category of computer science; that is, we hope that computers have the same human intelligence and learning ability, to solve some practical problems [8]. Artificial intelligence technology can assist in early disease diagnosis by analyzing a large amount of medical data, so as to greatly improve the diagnosis efficiency of doctors, reduce the misdiagnosis rate, and alleviate the shortage of medical resources. In recent years, artificial intelligence technology has been applied to all walks of life, and the medical treatment aspect is no exception, and it has shown great application potential in disease identification, diagnosis, and risk prediction [9]. Studies have shown that it is of great significance in skin cancer diagnosis of skin cancer, imaging tuition judgment, diabetic membranopathy type II, breast cancer classification, and so on. NCCT and the current application of artificial intelligence (AI) in medical field has reached or even exceeded the average diagnosis level of doctors.

As an important part of artificial intelligence technology, ML belongs to the field of computer science and engineering together with artificial intelligence. Artificial intelligence is a big concept. The most ideal artificial intelligence is a machine with the human general intelligence and mind, but this kind of artificial intelligence is difficult to achieve at present. What we can do now is "weak artificial intelligence"; that is, the level of performing specific tasks is equivalent to human beings, or even beyond human technology [9]. The human-machine game that can be seen in real life, unmanned driving, and medical imaging interpretation belongs to this category. ML is currently the main method to implement artificial intelligence; it is to use algorithms to parse data, like people. A way to learn from the data, extracts the patterns in the data, and then makes analytical predictions about the real world. With the increasing computer performance and explosive data growth, ML can tirelessly and continuously analyze and refine the huge amount of data, so as to solve some problems that are too complex for humans. At present, ML Jing has been widely developed in the medical field, and it has shown great potential and even achieved good results in the risk prediction of disease, identification and classification, and medical image classification. Many studies have shown that ML in lung nodules, thyroid nodules vs the diagnosis of skin cancer, breast cancer, and diabetic retinopathy can be close to or even far beyond the accuracy of human experts [10].

At present, artificial intelligence has penetrated into various fields, such as driverless driving, medicine, finance and trade, and other fields. ML is the core of artificial intelligence. ML is about using algorithms that enable machines

to learn rules from large amounts of historical data to intelligently identify new samples or make predictions about the future [11]. Deep learning is a new field in ML research. Deep learning methods simulate human neural networks, combine multiple nonlinear processing layer by layer, obtain different levels of abstract features from the data and use them for classification prediction. Many structural models of deep neural networks have been applied to medical imaging, such as convolution neural networks, sparse coding networks, stack autoencoders, restricted Boltzmann machines, and deep belief networks. Convolutional neural network can extract the features of the images, and the relationship between the image features and the image labels can be found out very accurately and efficiently, so as to complete the effect of image recognition or classification. Compared with humans in big data operation, the neural network can maintain continuous high precision. At present, there have been many examples of deep learning applications in the medical field, such as the diagnosis of heart diseases, the diagnosis of respiratory diseases, the diagnosis and differentiation of retinal diseases, the classification and diagnosis of tumors, and skull shadow-like, the diagnosis and classification of epilepsy carbuncle, Parkinson's diagnosis of hemorrhage after thrombolysis and so on.

3. Based on Machine Learning-Based Prediction of Hematoma Enlargement in Patients with Cerebral Hemorrhage

3.1. The ML Method for the Dual Model. Our ML method contains two predictive models. The first predictive model is a single-model predictor based on DCNN using the NCCN skull images only. The purpose of this prediction model is to predict the chance of hematoma expansion in each NCCT image, and the image information is transformed into probabilistic information for the next step. The second prediction model is a dual-model predictor that combines the prediction results from the first prediction model with the patients' clinical data, which is implemented through a neural network called multilayer perception (MLP). See the body steps in Figure 1.

3.1.1. First Prediction Model: Single Model Prediction Based on DCNN. The first model structure is shown in the upper half of the flow diagram. DCNN is one of the most successful deep learning technologies used for image recognition and classification, and a variety of DCNN models can achieve excellent image classification results, such as 34-layer Residual Network (ResNet34), Visual Geometry Group Network (VGGNet), and Google Inception Network (GoogLeNet). In this study, we used the Res Net34 to achieve single-model prediction trained using NCCT images, because it has the advantage of achieving deeper network training with limited data and achieving good performance.

ResNet34 is invented based on the VGGNet network structure, contains 34-layer structure and uses a convolutional kernel of 3X3. Unlike in VGGNet, the ResNet34 downsampling method is done by using a convolutional layer of a step size of 2 rather than a pooling layer. The most prominent feature of ResNet is the insertion of a structure called a residual block based on the VGGNet network structure, where the output value of each two layers is added to the previous input value so that the network structure can become deeper, and caused by. This yields a better predictive performance. Stacking many residual blocks together constitutes the basic structure of the ResNet34.

To better validate the classification performance of ResNet34, we compared it with the prediction performance of two other neural networks, including VGGNet and GoogLeNet. We trained three DCNN using two NCCT brain images of DCNN network models to test the predictive performance of different network models. As previously introduced in "Preprocessing of Images," we explored whether the image segmentation method that divides the hematoma part from the brain tissue background could improve the prediction performance, a step visible in the process graph. Each image was labeled, with hematoma enlargement labeled 1 and 0 without hematoma enlargement. The DCNN model was trained in 80 rounds, the initial learning rate was 10-3 (3 times lower per 20 rounds), the batch number of data was 60 images, and the optimizer was the Adam optimizer. A batch normalization method is used between each two convolution layers to prevent overfitting.

3.1.2. Second Prediction Model: Dual-Model Prediction Based on MLP. The second model is shown in the lower half of the flowchart. During the training process of the first prediction model, we obtained a single-model predictor (ResNet34) to predict the chance of hematoma expansion for each NCCT image. In this part, we will use a dual-model predictor based on the 1VB, P neural network, which combines the prediction results of ResNet34 with 10 patient clinical data to predict the chance of hematoma enlargement.

MLP is the most commonly used neural network model in ML. It consists of 1 input layer, 1 or more hidden layers, and 1 output layer 3 parts, to pass the input value from the input layer to the output layer and realize the mapping relationship between the input and the output. The first layer of the neural network is called the input layer, which is designed to receive various input data; the last layer of the neural network is called the output layer, which is the last result of the output network. Level 1 or more between the input and output layers is called hidden layers. Each layer is composed of neural nodes (or called neurons), and the points of the two adjacent segments are connected by the weights, referring to the first 1 nerve The magnitude of the effect value of the output of the element on the output of the next neuron. Values from each neuron in the first 1 layer were multiplied by 1 weight, and the resulting weighted values were then added together to obtain a combined value. The sum of the combined values is then entered into a transfer function whose output is passed to the next layer.

Due to the limited sample size data (140 patients), we chose to use a 3-layer MLP network with a relatively simple structure and a single hidden layer. The input values of MLP were predictive values from the single model predictor, age, gender, history of diabetes mellitus, coronary heart disease, smoking history, drinking history, hypertension history, baseline systolic BP value, time to the baseline NCCT, and

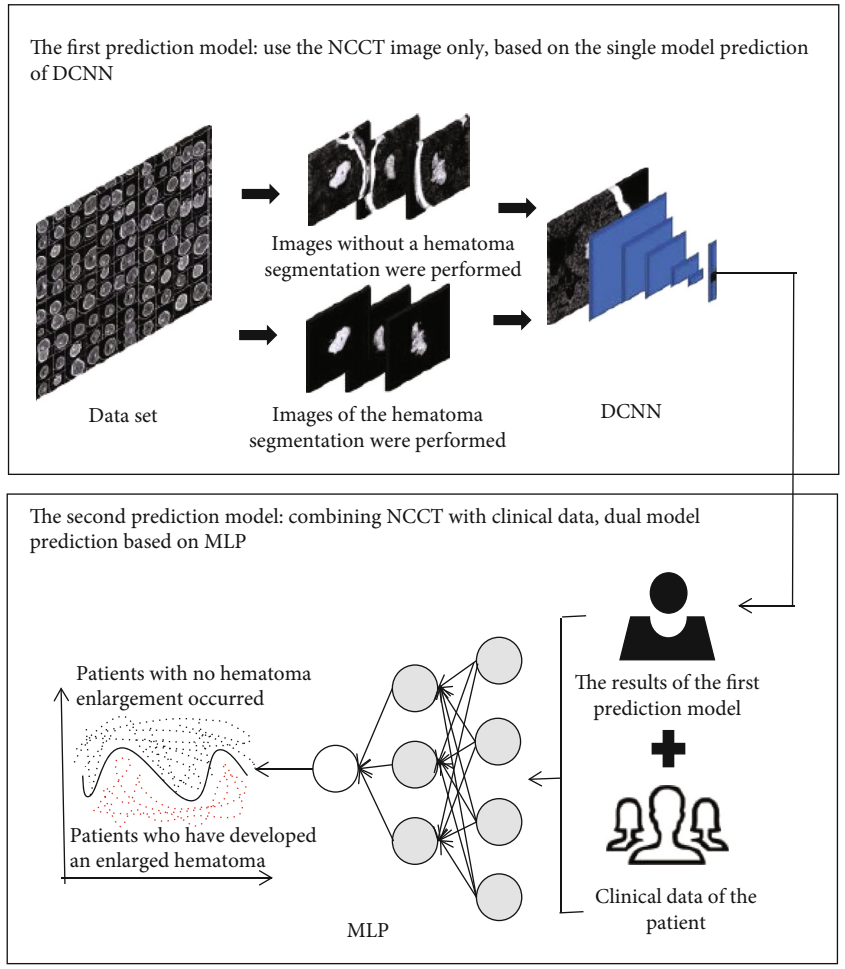


Figure 1: Flow chart.

hematoma volume shown by the baseline NCCT. Notably, the ResNet34 predicts the chance of hematoma enlargement per NCCT cranial image, and in this part, we need the value of each predictive value of hematoma enlargement in 10 patients. Therefore, for each patient, we first use the first prediction model to predict the chance of each hematoma image, and then calculate the number of predicted positive images in the proportion of all images, so as the chance of the patient, namely the input value of the second prediction model.

The output values of the MLP network were predictive of hematoma enlargement in 1 patient. The number of nodes in the input and output layer is determined by the number of input and output variables, so that the input layer of the network consists of 11 neurons, and the output layer consists of 2 neurons. Neural networks optimize the best effect of classification by constantly adjusting the number of neurons and the number of hidden layers in the hidden layer. We tested the number of neurons ranging from two to eight in the hidden layer to determine the optimal number of neurons. During the course of training the MLP, we used the patients in the whole training set for batch training. The initial learning acquisition rate was 10-3, using the optimizer for the Adam optimizer.

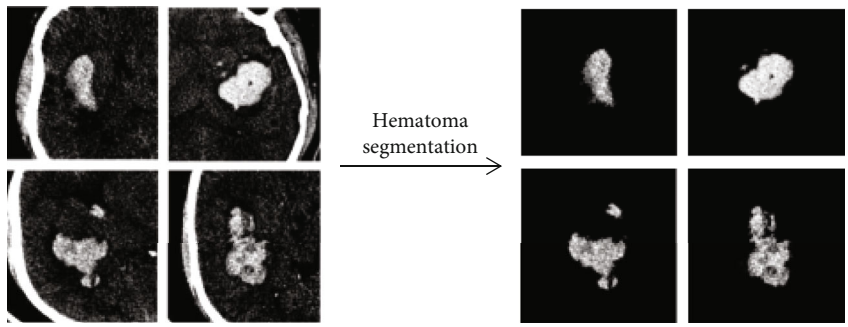
3.2. Data Collection. Through retrospective analysis, ICH patients treated in our hospital in 2021 were selected as study subjects, and patients were complete and clear. According to the screening criteria, patients were adults, and patients gave informed consent to ensure baseline NCCT examination within 6 hours after ICH symptoms, and NCCT scan within 48 hours after baseline NCCT scan.

The hematoma volume was measured as follows: using the abc/2 formula, where a is the maximum hematoma diameter of the NCCT, b is the opposite diameter of 90° from a, and c is the approximate number of NCCT sections of the hematoma times the thickness of the section.

3.3. Preprocessing of the Images. Both baseline and review NCCT image scans were performed using standard clinical parameters with an axial thickness of 5 mm. NCCT images were acquired and saved in Medical Digital Imaging and Communication Format (digital imaging and communications in medicine) DICOM. To minimize the interference of irrelevant information, only the levels containing the hematoma images were selected from the NCCT images, and the levels without the hematoma images were discarded. To meet the image pixel values required for the subsequent ML analysis, the initially filtered NC was entered. The CT

Table 1: Comparison of the clinical characteristics of the patients with and without hematoma enlargement.

Patient profile characteristics	Patients who have developed an enlarged hematoma ($n = 114$)	No patient developed a hematoma enlargement ($n = 166$)	P
Average age (SD)	63.1 (12.5)	56.95 (11.8)	0.003
Gender (man)	40 (70.2%)	51 (61.4%)	0.287
History of drinking	21 (36.8%)	32 (38.6%)	0.837
History of smoking	25 (43.9%)	31 (37.3%)	0.440
Medical history of hypertension	46 (80.7%)	62 (74.7%)	0.406
History of diabetes	9 (15.8%)	8(9 .6%)	0.274
HDH	12 (21.1%)	8(9.6%)	0.058
Baseline SBP value (SD)	171.9 (22.6)	153.6(21.1)	0.001
Time to baseline NCCT (SD)	2.9 (1.36)	4.1(1.28)	0.027
Hemoma volume at baseline NCCT (SD)	26.1 (15.57)	13.4 (12.40)	0.018



(a) Images without the hematoma segmentation

(b) Images of the hematoma segmentation were performed

Figure 2: Example of the hematoma segmentation results.

images were centered at the image center of gravity and trimmed to a square of 227 ∗ 227 pixels containing the hematoma area as an input image for further using ML analysis. In this step, we discarded images with trimmed hematoma areas of less than 200 pixels, because they were difficult to distinguish from the background brain tissue. To speed up Nll, the efficiency of the analysis, we normalized and normalized all the trimmed images, with all the pixel values normalized to between 0 and 1.

Regarding the hematoma segmentation, here, we used a salient object detection method. This method is based on deep convolutional neural network (DCNN), which is fully called deep supervised saliency object detection with short connections. Unlike previous salient object detection methods, this new salient object detection system introduces a series of short connected structures into the original structure, characterized by combining the output of the deep structure of the prediction model and the output of the shallow structure. By combining different deep networks information about the structure, this short connection structure can provide more abundant information to each layer of the prediction model; that is, the image information extracted from multiple layers from deep structure to shallow structure. Unlike simple object edge detection, salient object detection methods can identify the most visually distinct objects and regions in an image and then segment them from the background. For the above reasons, we used this new significant object detection method for hematoma region segmentation. And in addition to extracting edge features, we expect that more details of the hematoma image can be extracted using this method.

3.4. Model Performance Evaluation. Clinical variables included four continuous variables (age, baseline systolic blood pressure, time from onset to baseline NCCT, hematoma volume size at baseline NCCT) and six categorical variables (gender, alcohol consumption history, smoking history, hypertension, diabetes history, history of heart disease history). Categorical variables were expressed as percentage and continuous variables as mean standard deviation. The t-test was used for continuous variables and categorical variables using $\chi 2$ test or Fisher test to compare differences in demographic characteristics, differences in clinical data, and imaging information between groups of patients with hematoma enlargement and patients without hematoma enlargement. In all statistical points, the analysis was performed using the SPSS software (version 25). A p value of <0.05 was considered statistically significant.

Table 2: Comparison of results from training different networks using images without and hematoma segmentation.

	ResNet34		GoogLeNet		VGGNet	
	W	*A*	*W*	*A*	*W*	*W*
Precision	69.5%	66.7%	66.5%	63.4%	62.4%	60.1%
Sensitivity	75.4%	73.1%	63.2%	60.4%	50.6%	48.0%
Specificity	64.9%	61.8%	69.1%	65.8%	71.7%	69.4%
P	62.6%	59.9%	61.5%	58.0%	58.2%	55.1%
N	77.2%	74.6%	70.7%	68.0%	65.0%	63.1%
AUC	0.73	0.70	0.68	0.65	0.65	0.60

Note: No hematoma segmentation is represented by "*W*", and no hematoma segmentation is represented by "*A*". Positive predictive values are indicated "*P*" and negative predictive values are "*N*".

Subjects' operating characteristics curve (the receiver operating characteristic, ROC) and the area under the curve (AUC) value are depicted to evaluate the prediction performance of the above networks.

Two parameters were used to evaluate the segmentation effect of hematoma segmentation, including F metric values and mean absolute error. For a given continuous significance map S, we converted the threshold to a binary mask B, and then calculated its precision and recall as

$$\begin{aligned} \text{Precision} &= \frac{|B \cap Z|}{|B|}, \\ \text{Recall} &= \frac{|B \cap Z|}{|Z|}, \end{aligned} \tag{1}$$

where Z represents the positive values in the binary atlas, and $|.|$ represents the nonzero entries in the cumulative mask. F is used to comprehensively assess the quality of the explicit map, as defined as

$$F = \frac{\left(1+\beta^2\right)\text{Precision} \times \text{Recall}}{\beta^2 \text{Precision} + \text{Recall}}. \tag{2}$$

Usually β^2 sets it to 0.3 to indicate the importance of accuracy. The mean absolute error represents the average difference between the explicit map value and the label value, with the calculation formula:

$$\text{MAE} = \frac{1}{H \times M} \sum_{i=1}^{H} \sum_{j-1}^{W} \left| \widehat{S}(i,j) = \widehat{Z}(i,j) \right|. \tag{3}$$

S and Z represent explicit map values and tag values, respectively, normalized to between [0,1].

The sensitivity, specificity, positive, negative, and accuracy of the DP and MCNN models predicted results were calculated separately to evaluate the performance of the model predictions.

We used the 10-fold cross-validation method in calculating the above prediction evaluation results to obtain more reasonable results and prevent the contingency of the results caused by 1 calculation. In the practice of this method, we conducted 10 training procedures and calculated predictors for DCNN and MLP. Before each training, the training set, test set, and validation set were randomly assigned again, using the average of 10 training results as the final model prediction results. During the training process, we used 75% of the data set as the training set, 15% as the test set, and 10% as the validation set.

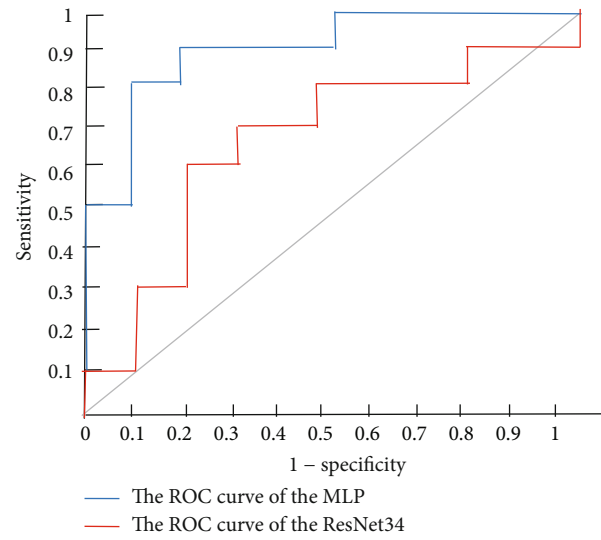


Figure 3: The ROC curves for MLP in double model predictions and the ROC curves for ResNet34 in single model predictions, with AUC values of 0.91 and 0.68, respectively.

4. Analysis of the Experimental Results

4.1. Basic Patient Data. Of the 140 patients selected, male patients were relatively large, reaching 91, with an age range ranging from 30 to 85 years. The basic data of the patients are summarized as follows: the differences in the clinical data characteristics between the two groups with developed hematoma enlargement and no hematoma enlargement are shown in Table 1.

4.2. Image Preprocessing Results. After image processing, a total of 5616 NCCT images in DICOM format were obtained from 140 patients with ICH, including 2635 hematoma images from 57 patients with hematoma enlargement and 2982 hematoma images from 83 patients without hematoma enlargement. The hematoma segmentation yielded good results, with an F metric value of 0.96 and a mean absolute error of 0.0043. An example of the four hematoma segments is shown in Figure 2.

4.3. Performance Evaluation of ML for Predicting Hematoma Enlargement. The results of the first prediction model, the comparison of the prediction performance of ResNet, VGGNet, and GoogLeNet 3 network models, and the results of using images with hematoma and image trained networks without hematoma segmentation are shown in Table 2. As we expected the results, the ResNet34 network model achieved the highest accuracy in predicting hematoma enlargement methods. However, unlike our previous expected results,

Table 3: Comparison of results for different numbers of neurons in the MLP hidden layer.

No. of neurons in the hidden layer	Precision	Sensitivity	Specificity	AUC
2	71.4%	80.0%	68.8%	0.73.
3	76.2%	77.8%	75.0%	0.79.
4	81.0%	85.7%	78.6%	0.83
5	86.5%	82.6%	88.9%	0.93
6	81.0%	71.4%	85.7%	0.82
7	76.2%	77.8%	75.0%	0.79
8	71.4%	85.7%	64.3%	0.73

DCNN network models trained with images without hematoma segmentation have a prediction accuracy than trained with images without hematoma segmentation The DCNN network model predicts 2%-3% more accuracy. The above situation is present in the 3 network models. Therefore, the model that achieves the best prediction results in the single-models prediction based on the DCNN is the ResNet34 model trained using the NCCT images without the hematoma segmentation. The prediction accuracy, sensitivity, specificity, positive predictive value, and negative predictive values were 69.5%, 75.4%, 64.9%, 62.6%, and 77.2%, respectively (as shown in the first column in Table 1). The AUC value is 0.68 and the ROC curve is shown in the red line in Figure 3.

The second prediction model is 1 two-model prediction based on MLP. To determine the number of neurons in the hidden layer in the MLP model, we tested the predictions for different numbers of neurons, as shown in Table 3. The MLP model with 1 hidden layer containing 5 neurons achieved the highest prediction accuracy in predicting hematoma enlargement. Happily, the two-model predictor is 17% more accurate than the single-model predictor. The prediction results of the dual-model predictor using NCCT images and clinical data are accuracy, sensitivity, specificity, positive predictive value, and negative predictive value are 86, respectively. 5%, 82.6%, 88.9%, 90.9%, and 80.0%. The AUC value is 0.91, and the ROC curve is shown in the blue line in Figure 3.

5. Conclusion

This paper is mainly based on machine-learning prediction study of hematoma expansion in patients with cerebral hemorrhage. By explaining the two-model ML method and combined with specific clinical case data, the ML method has certain advanced nature through experiments.

Only a single-model predictor trained using NCCT images has limited accuracy in predicting hematoma expansion. Image segmentation methods that separate the hematoma part from the brain tissue background fail not improve the predictor performance for hematoma enlargement.

The final ML method of dual-model prediction can comprehensively analyze the patient NCCT image information and clinical data, which can achieve 86.5% accuracy and have relatively equal sensitivity and specificity. Therefore, this ML method can be used as a predictive tool to effectively identify people at high risk of hematoma expansion.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

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Retraction

Retracted: Analysis of Multiple Linear Regression Algorithm for High Quality Development Factors of Cross-Border E-Commerce

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] H. Fang, "Analysis of Multiple Linear Regression Algorithm for High Quality Development Factors of Cross-Border E-Commerce," *Journal of Sensors*, vol. 2022, Article ID 4020607, 11 pages, 2022.

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Research Article

Analysis of Multiple Linear Regression Algorithm for High Quality Development Factors of Cross-Border E-Commerce

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With the in-depth development of Internet technology as well as information technology, the continuous popularization of computers in China, and the increasingly obvious economic globalization, the world's economies are becoming more and more closely connected. Cross-border e-commerce has been developed better. In China, with the deep and continuous development of China's reform and opening up, as well as the continuous improvement of our country's science and technology level, the continuous improvement of people's living standards and the internationalization of our country's enterprises are getting stronger. E-commerce in China has also been developed significantly. According to the statistics of China's National Bureau of Statistics and relevant scientific research institutions, since China entered the modernization, China's cross-border e-commerce are multiplying the high-speed growth state, especially after China's entry into the WTO, China's cross-border e-commerce business is growing rapidly, in the process of China's cross-border e-commerce development, compared with imports, exports are taking the absolute dominant position. Therefore, the quality of goods in China, the implementation of standards and related laws and regulations and policies, then become a relatively core part of cross-border e-commerce. Among all the core parts, the quality of goods is undoubtedly the most core part. Under the supervision of our national departments and law-making and other factors, the regulator of the e-commerce platform is the main body of commodity quality supervision. Therefore, the managers of e-commerce platforms are of vital importance to promote the development of e-commerce platforms. In this paper, in line with the principle of promoting the high-quality development of cross-border e-commerce in the prospect of high-quality development of China's e-commerce platform, a series of multivariate linear models on the development of e-commerce platform carry out the analysis of China's high-quality development of e-commerce. The main body of China's e-commerce, the country, as well as consumers, producers, and other optimization analysis is from the overall analysis of China's e-commerce platform development status. The current problems of China's e-commerce platform, according to this to carry out the overall planning, put forward the countermeasure suggestions studied in this paper.

1. Introduction

In the process of this paper, we find that Hong Kong's cross-border e-commerce has developed unexpectedly well under this epidemic and the current situation of reverse globalization in the United States. It may be because of his own resilience and potential, as well as the strong support from our inland, that Hong Kong's cross-border e-commerce has such a superior development path. But after the current epidemic since 2020, the transaction scale of China's cross-border e-commerce has shrunk to a great extent than before the epidemic. Now, China's cross-border e-commerce is facing various difficulties such as high competitive pressure as well as weak awareness of rules, weak legal awareness, and related, for example, stricter regulatory measures on Amazon platform, and even higher logistics costs in China [1]. Since the outbreak of the new crown epidemic, global trade has shrunk to a great extent, and although logistics has also been affected to a certain extent, it is just such an epidemic that brings great prospects for the development of cross-border e-commerce [2]. According to the National Bureau of Statistics as well as the Ministry of Commerce, in the first year of the epidemic outbreak in China, the scale of cross-border e-commerce in China was surprisingly high at US$10 trillion, which increased by more than 10% [3]. Only in the first half of the first year of the outbreak, the

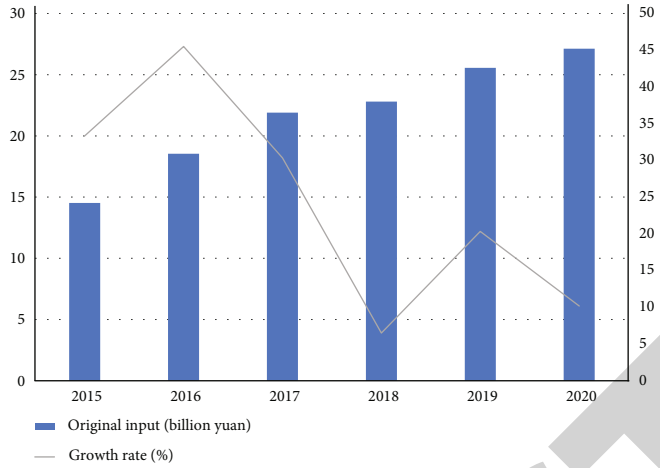

Figure 1: China's investment in the construction of cross-border e-commerce information.

scale of cross-border e-commerce in China has exceeded 5 trillion, which is far higher than the predicted level of the relevant departments in China [4]. During our next five-year planning process, China decided to set the scale of cross-border e-commerce at over $20 trillion. This target is due to the continuous technological progress, the continuous improvement of legal norms, and the continuous improvement of production capacity in our country, which is the confidence in our overall great power advantage. Of course, in my current country has had a long development, and our country's technology level has been higher, networked. The level is also higher, the level of modernization is higher, and our legal system is more robust, so we have an increasing advantage. But with the outbreak of the epidemic, our country has entered the postepidemic era. In this era, we have to focus on improving the level of offline real economy, so there is another negative impact on the development of cross-border e-commerce. Therefore, we have to further improve the level of seniority and further study the double-loop strategy to improve our foreign trade [5]. China has invested in the construction of cross-border e-commerce information, as shown in Figure 1.

2. Research Background

After China entered the epidemic period, the development of China's cross-border e-commerce is not because the global market demand is relatively large, but still because of the strong support of China's policy, not only the industrial chain, supply chain stability policy, but also includes China's double-cycle strategy, all of which provide strong policy support for the further development of China's cross-border point on [6]. Under the epidemic, China's State Council led the Ministry of Commerce as well as the Customs Department and other joint departments to issue a series of relevant documents and preferential policies to reduce the logistics costs, tax costs, and other transportation costs of China's cross-border e-commerce, providing long-term support for the development of China's cross-border e-commerce. China has also established more than one hundred business free trade zones to carry out commercial trade to promote the further development of cross-border e-commerce as a way to drive the local economy and expand the international market for China's cross-border e-commerce [7]. Of course, after the introduction of some relevant policies in China, all kinds of e-commerce platforms also gradually sum up their advantages to continuously adapt to the current policy and provide a higher level of platform. Based on the policies of 9610 and 1210 in China, the relevant cross-border e-commerce operation models of 9710 and 9810 have been added [8].

Under the influence of the epidemic, the habits of the vast majority of the population have undergone significant changes. With the advent of the epidemic era, people began to seek high-quality products and higher brand requirements. During the epidemic, Chinese sellers mostly dominated the market for cross-border e-commerce services in terms of delivery and low prices. However, with more and more competitors entering the industry, sellers no longer have an advantage in the distribution model, and those using the branded sperm line have a better advantage. Anchor has aggressively rebranded itself to quickly capture the leading market share in the Amazon region. The annual revenue growth rate exceeds 30%, creating a tremendous growth opportunity [9]. In 2021, the Amazon platform provides great help to merchants in brand building and helps them to establish their brands quickly. In its annual report for 2021, it released a report on sellers. The report found that more than 90 percent of Chinese sellers are interested in building their brands on Amazon, and more than three-quarters are confident and experienced in building their brands on Amazon. According to an Amazon study, many new brands and new users come to Amazon each year, but many also go out [10]. Many salespeople struggle to survive in the process of building their brands. This shows that brand building has a huge advantage for multinational companies in the postepidemic era. Chinese sellers with quality products and services will have more incentive to grow if they seize the opportunity of branding [11].

The 2019 coronavirus epidemic has led to economic stagnation overseas and a lack of demand in overseas

markets. China is the first country to enter the postepidemic era with rapid growth of multinational e-commerce companies. However, due to the epidemic, transportation time was long, logistics were congested, and logistics were difficult and slow. As a result, the delivery period of many goods has been extended [12]. Considering the current logistical challenges, the establishment of offshore warehousing has become a growth opportunity for many Chinese sellers. Setting up offshore warehousing means establishing warehouses in the destination country to solve the problem of long and timely delivery and warehousing for the first and last shipments. Setting up a foreign-owned warehouse locally also keeps up with local developments and is beneficial to the long-term development of the company. The Fourteenth Five-Year Plan for E-Commerce Development (National Policy 2021) calls for openness and win-win cooperation to support the construction of overseas warehouses. However, the cost of setting up warehouses overseas is huge, and it is difficult for small and medium-sized companies to reach this goal. Currently, companies can jointly set up overseas warehouses to jointly solve the current logistical warehousing problem and seize the opportunity to achieve more effective development together [13].

This policy aims to facilitate the development of cross-border e-commerce. In the past, Chinese cross-border electrical companies relied too much on third-party platforms. However, more and more companies are starting to operate independently from third-party platforms. Many companies have started to develop independent websites, social media, real-time transactions, and other sales channels. Independent websites have become an alternative to the new trend for many companies [14]. Establishing an independent e-commerce website can avoid the many rules of the platform, facilitate brand building and customer care, and contribute to the long-term stability of the company. Currently, more and more multinational e-commerce companies are in the stage of exploring independent websites. In the postepidemic period, new trends in cross-border e-commerce development include the establishment of independent e-commerce websites, the development of private mobility models, and multiplatform behavioral models [15]. China's cross-border e-commerce transaction volume and growth rate from 2015 to 2020 are as shown in Figure 2.

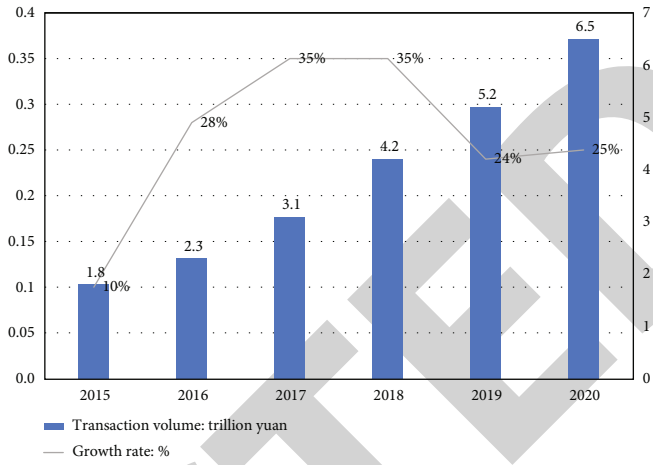

Figure 2: China's cross-border e-commerce transaction volume and growth rate 2015~2020.

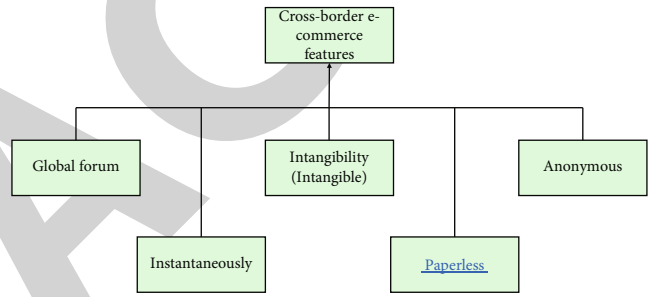

Figure 3: Cross-border e-commerce characteristics.

3. Materials and Methods

3.1. Basic Theory

3.1.1. Cross-Border E-Commerce. Cross-border e-commerce, as the name implies, is a business model based on electronic information technology and Internet technology formed on the basis of cross-border borders. The online business mode within a country or a region is called e-commerce, so it gives rise to the concept of cross-border e-commerce in the cross-region or cross-country e-commerce operation mode. Cross-border e-commerce has advantages over traditional cross-border trade as well as traditional e-commerce that other business modes do not have. First of all, it is established under the background of global economic globalization, promotes the development of economic globalization, and bridges the economic and trade ties between countries as well as the related cultural customs and civilization exchanges. There are many models of cross-border e-commerce, of course, our common cross-border e-commerce is the B2b model based on the third-party platform. There are also some of our more common B2C models as well as c2c models and even later evolved b2b2c models [16]. Cross-border e-commerce characteristics are as shown in Figure 3.

In the author's research on the collation of relevant types of literature, it was found that no research on the quality development of cross-border e-commerce in China was conducted using multiple linear regression algorithm modeling. Well, the analysis of that means that for that type of model is still relatively small. The research on cross-border e-commerce, which is less in the related economics field, is still mainly distributed in e-commerce research and research on laws and regulations and industrial economy, and even foreign trade and English language have a long research on cross-border e-commerce. However, there are relatively few studies on modeling cross-border e-commerce based on the establishment of multiple linear regression models, so this paper encounters great difficulties in modeling. This paper has to finely consider each factor related to the development of cross-border e-commerce and calculate their correlation coefficients and the statistical estimation of their parameters [17]. Several main aspects of the current situation of cross-border e-commerce in China and its related

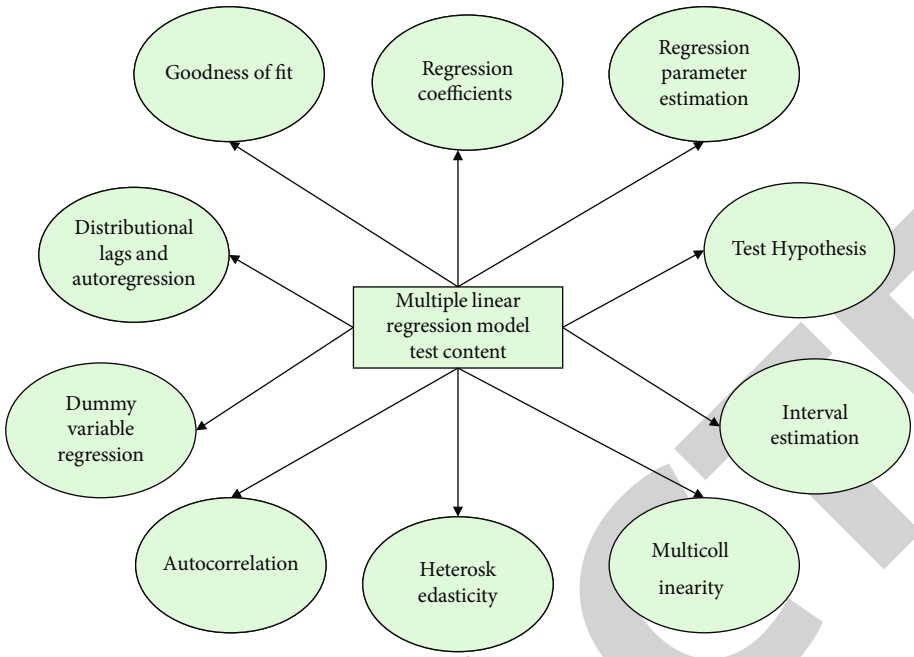

Figure 4: Multiple linear regression model test content.

important factors were carefully selected for an in-depth analysis, the current situation of cross-border e-commerce development in China was examined, and relevant suggestions and outlooks were put forward for the current situation of development in China [18].

3.1.2. Multiple Linear Regression. The multiple linear regression model algorithm is based on a multiple linear regression model. Multicomponent linear regression considers any practical statistical, mathematical or economic problem [19]. In practical applications, the correlation analysis of independent variables often includes many variables that are usually more closely related to many of them. Therefore, many variables are introduced in linear regression to build multivariate linear regression models.

In our general regression analysis, such as linear regression, there is only one term, one variable, but only one independent variable to explain the cause, the so-called probabilistic linear regression model. Thus, if there are multiple variables, there are multiple independent variables to explain multiple factors [20]. This can be explained by several variables. I point out the linear relationship between them, and that is all there is to the linear regression model.

Given the high quality of cross-border e-commerce, several factors should be considered in this study, but not just one of them. Therefore, in order to conduct a relevant study, a multiple linear regression model algorithm must be introduced. In addition to regression analysis, multiple colinear, variance, and autocorrelation analyses are required. The multiple linear regression model for the test content is shown in Figure 4.

3.2. Research Method. In this paper, the research method of multiple linear regression model is used to simulate the correlation of various linear regression models. The specific modeling is shown below. The specific flow of the algorithm is as shown in Figure 5.

Considering the limitations of the algorithm, scholars at home and abroad have proposed a series of improvement schemes. The multiple linear regression model has a certain purpose, so the scheduling algorithm is naturally more efficient. In order to improve the performance of the multiple linear regression model, the Zaire method introduces parent node information in the multiple linear regression model, which reduces the number of expansion nodes and scheduling time. In the early 19th century, the field of econometrics developed multiple linear regression models, developed new node control criteria, improved search efficiency, smoothed paths, and found paths that matched the motion characteristics of the robot.

Such algorithms, first of all, perform a clustering analysis of the data by some algorithm, thus obtaining the central part of the hidden neural network, and then use the results of this step to perform calculations to figure out the width value of the number. The specific width values are calculated as follows.

$$\sigma_j = \frac{c_{xy}}{\sqrt{2h}}. \tag{1}$$

In the c_{Xy} formula, start calculating the maximum distance to the centroid, and $h$the specific is the number of nodes.

After the input data is analyzed in the implied layer with the output layer for the relevant data, the output x_i of the first node j of the input sample in the implied layer is calculated by the following equation.

$$\phi(x_i, j) = \exp\left(-\frac{1}{2\sigma_j^2} x_i - c_i\right). \tag{2}$$

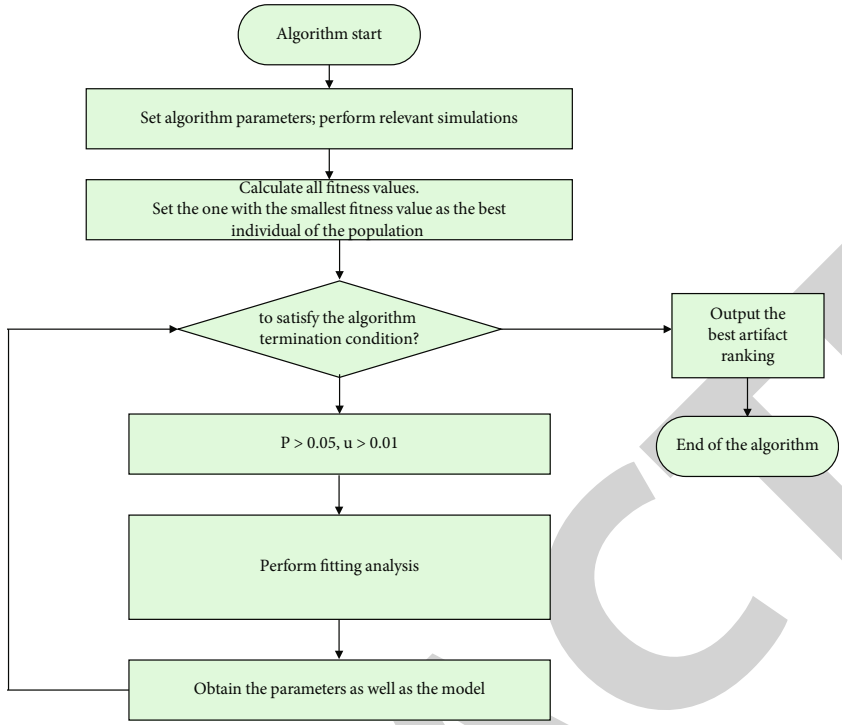

Figure 5: Algorithm specific flow.

In the formula, c_j is the centroid of the node in the first layer; the σ_j is the width value of the node in the first layer.

The output of x_i the first node of j the input sample in the output layer is calculated by the following equation.

$$y_m = \varphi(\phi(x_i, j) * w_m). \tag{3}$$

In the w_m formula, the node is associated with the involved weights; φ is the function of the involved weights.

Let (Ω, ζ, P) be a conceptual space, and x is the set of all wandering variables on the space involved. The risk measure ρ is a mapping x from a x_ρ subset of R to the real numbers, denoted as $\rho : X \in x_\rho \leftrightarrow \rho(X) \in R$.

First define the g function called distortion function, if $g : [0, 1] \longrightarrow [0, 1]$, it is a monotone nondecreasing function and satisfies $g(0) = 0, g(1) = 1$.

Next, define the $\rho_g : x \longrightarrow R$ risk measure: often called distortion risk measure, if $\rho_g(X)$, it satisfies

$$\rho_g(X) \coloneqq \int_{-\infty}^{0} \lg\left(S_X(x)\right) - 1\Big) dx + \int_0^{\infty} \mathrm{g}(S_X(x))\Big) dx, X \in x. \tag{4}$$

Here is g the distortion function, which $S_X(x) = P(X > x)$ is X the tail distribution.

The X assumption is that the total risk faced $f : [0,\infty) \longrightarrow [0,\infty)$ by the insurer $f(X)$ is the partition function, representing the insurer transferring part of the risk faced by itself to the reinsurer. The reinsurers charge the insurer for the insurance premiums to supplement the risks they bear because they assume a portion of the insurer's risks. In this paper, we assume that the reinsurance cost criterion has the following form.

$$\mu_r(f(X)) = \int_0^{\infty} r\Big(S_{f(x)}(x)\Big) dx, \tag{5}$$

where $S_{f(x)}$ is $f(X)$ the tail distribution $r : [0,\infty) \longrightarrow [0,\infty)$ about and is a monotonic nondecreasing $r(0) = 0$ function with. Without loss of generality, we assume r that it is not a function that is zero almost everywhere, and that the total risk an insurer has to face is the residual risk it will face plus the cost required to transfer the risk. Expressed in the formula, it can be expressed as

$$T_f(X) = X - f(X) + \mu_r(f(X)). \tag{6}$$

This paper also provides a detailed step-by-step analysis of the specific fitting process of the multiple linear regression model, as shown in Figure 6.

4. Results and Discussion

4.1. The Current Situation of Cross-Border E-Commerce and Its Problems

4.1.1. The Current Situation of Cross-Border E-Commerce. The spread of the new crown pneumonia epidemic at the end of 2019 led to a rapid decline in the world economy. At the end of 2019, the epidemic swept through countries rapidly, and the whole world was not able to avoid the New Crown epidemic. Although our country is the most active and advanced country in epidemic prevention and

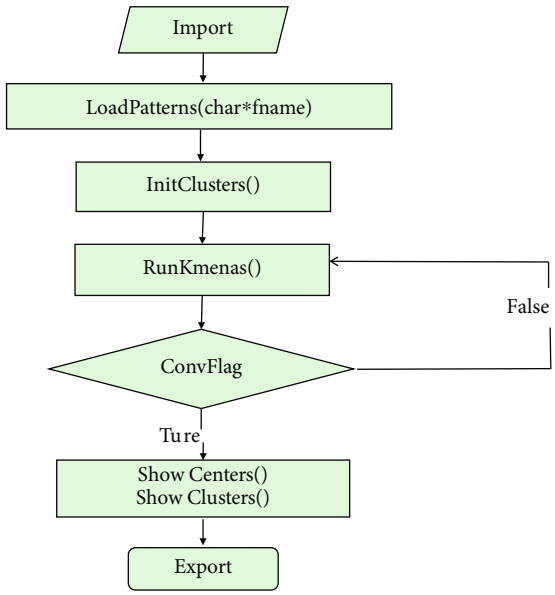

Figure 6: Multiple linear regression model specific fitting process.

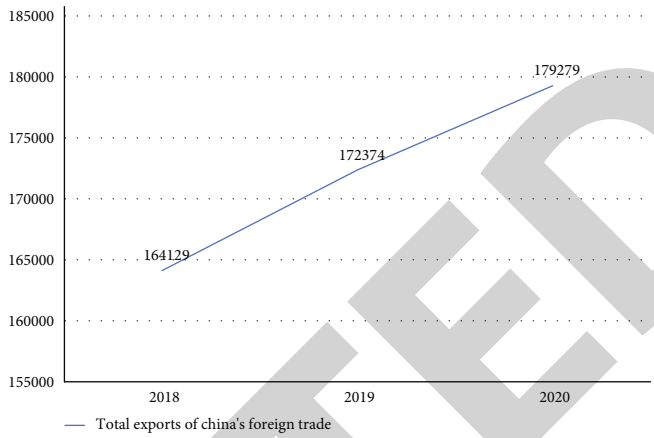

Figure 7: China's foreign trade exports in 2018~2020.

control as well as treatment, the prevention and control are the most strict. However, since China entered the postepidemic era, our industry chain, supply chain, and supply levels were greatly affected, and people's willingness to consume was greatly affected. Although our country quickly adjusted the relevant strategies and carried out large-scale monetary policy regulation, the overall regulation strength of our country was only able to maintain the domestic cycle level. For the rapid spread of the epidemic abroad, the international industry chain, supply chain and supply, and other disruptions in demand reduction, China is still not able to respond in a timely manner. Many foreign trade enterprises have fallen into a rather difficult dilemma. The development of cross-border e-commerce in China has been further hit. However, with the global vaccination, the spread of the epidemic is still relatively rampant, but has been more effective control, to better achieve the stability of the industrial chain, supply chain, etc. According to data from the Ministry of Commerce, the National Bureau of Statistics and the General Administration of Customs, China's total foreign trade exports in the middle of 2018-2020 show a rising trend, and the total rise is relatively large. It has an annual growth ratio of more than 5%. During this period, the foreign trade exports brought by cross-border e-commerce in China exceeded 20% of the total exports, which accounted for a great proportion in China's foreign trade exports and had a very important impact on China's foreign trade, as shown in Figure 7.

The number of cross-border e-commerce users has surged. Under the influence of the epidemic, not only the cross-border e-commerce in China has surged but also the online stores in China have increased to a great extent. Due to the wind control, China's cross-border e-commerce increase more extremely, although China's domestic e-commerce laws and regulations and related norms are more perfect, but the process of China's foreign trade, the relevant rules do not align well with the international. Under the influence of the epidemic, China not only increased the number of cross-border e-commerce users but also the number of related business staff, not only the employment of the store platform increased more, and the number of relevant customs and business departments in China's monitoring team is also climbing, according to the statistics of our relevant departments, our users increased by more than 20%, which is an unprecedented situation, the number of advocates increased by more than ten million. Our relevant platform staff as well as new employment in the stores have also increased by as much as 200,000. After the epidemic, it is clear that cross-border e-commerce in China has become a dark horse, far away from the impact of the real economy. It had a huge impact on our economy, and of course during the rapid development of cross-border e-commerce, China also gradually accepted some other western consumer holidays, such as Black Friday and some other consumer holidays, and our 618 and Double 11 consumer holidays were also integrated into western shopping. With the impact of the epidemic, China's cross-border e-commerce interactions with foreign countries gradually stepped into the normalization stage, as shown in Figure 8.

4.1.2. Problems of Cross-Border E-Commerce. Increased pressure of industry competition. Faced with the increasingly fierce competition in international commerce today, the impact of the new crown epidemic has caused further setbacks in the development of international commerce. Although international commerce is further frustrated, but cross-border e-commerce on the long-term development. Especially after countries developed the vaccine, the popularity of the vaccine made the world's epidemic has been effectively controlled, although the control is not obvious enough in foreign countries. But during this period, cross-border e-commerce has been better developed. Compared with traditional international business models, e-commerce has advantages that traditional business models do not have. Its dissemination of information and its huge scale and strong support from various countries have helped a lot in the development of e-commerce in the world. Our party

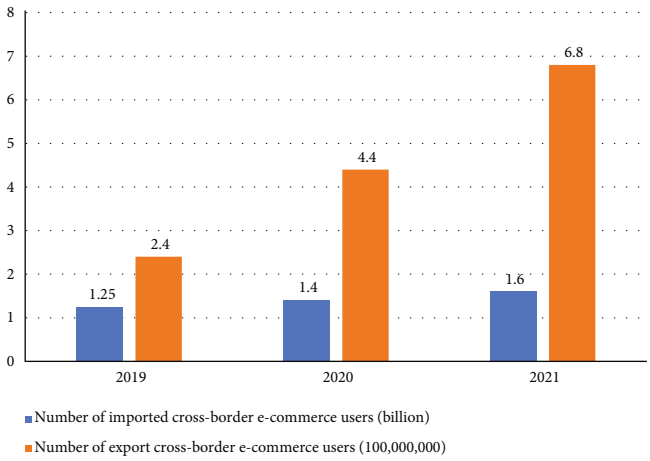

Figure 8: Number of cross-border e-commerce users in China's import and export in the first half of 2019~2021.

and government have given great policy support to our e-commerce platform as well as e-commerce work-related personnel stores and related factory ends. Since cross-border e-commerce attracts many people's employment and has huge employment potential in the production end, sales end, and logistics end, our party and government attach great importance to it. The development of cross-border e-commerce gives cross-border e-commerce with to great policy support. Even for nondomestic platforms, such as Alibaba and Jingdong, platforms other than these platforms, such as Amazon and other platforms, have considerable strength support. Although compared to Amazon, China's Alibaba and Jingdong's e-commerce platform development is slower, and authority and visibility are relatively low, but China's platform has a longer-term development. Let us start with the store sellers again. During the epidemic in China, the number of stores in China's cross-border e-commerce increased by 1 million, of which 70% of merchants opened such cross-border business stores for the first time. It can be concluded that in the postepidemic era, China's cross-border e-commerce industry is constantly flooded with new competitors, and the competition in the industry is getting fiercer.

Stricter platform rules. In response to the sudden outbreak of the epidemic, many cross-border e-commerce sellers were unable to make timely deliveries and stock preparations, and cross-border e-commerce platforms introduced a series of support policies during the epidemic, such as Amazon, eBay, Speedy Trading, and other cross-border platforms opened a "holiday mode" for some sellers affected by the epidemic, which means merchants can delay order processing and delivery during this period. With the global spread of the new vaccine, the epidemic was brought under control, and all major factories resumed work and production. After entering the postepidemic era, cross-border e-commerce platforms introduced stricter platform rules than during the epidemic in order to rectify the e-commerce order. In addition to the Amazon platform, other e-commerce platforms have also cracked down on seller violations. As can be seen from the data, the platform rules continue to be regulated in the postepidemic era, resulting in large losses for many Chinese cross-border e-commerce enterprises, many of which have fallen into development difficulties.

Increased international logistics and transportation costs. The arrival of the epidemic has opened up a path of development for cross-border e-commerce, but along the way cross-border e-commerce enterprises are faced with the huge problem of logistics. All aspects of international logistics are affected by uncertain factors, and time and economic costs are increasing. The arrival of the postepidemic era has also ushered in a new spring for Chinese sellers, who have started to ship, replenish and prepare their goods, further increasing the flow of international goods overnight, resulting in bursting of warehouses. The price has been several times higher than at the beginning of the epidemic. The price of iron transportation has also remained high, while the price of sea transportation has increased less, but the cost of time has been increasing. http://hugo.com/ research data launched in December 2020 shows that in 2020, 47% of sellers' logistics costs increased by more than 50%, and 17% of sellers' logistics costs increased by up to 100% or more. The soaring freight costs have kept cross-border e-commerce enterprises under attack, and they have to face other logistics problems such as difficult transport, difficult distribution, and increased storage fees, leading to a continuous decline in their product profits. How to reduce the cost of international logistics and transportation has become a major problem that cross-border e-commerce enterprises need to solve in the postepidemic era.

4.2. Causes of Export Cross-Border E-Commerce Problems. According to the division of unqualified elements, export cross-border e-commerce unqualified goods include two categories: one is the appearance of unqualified, that is, unqualified logo class, and the other is the quality of unqualified, that is, inferior products. The main causes of commodity quality problems are analyzed as follows.

(1) *Low Market Access Threshold.* Cross-border e-commerce without special professional entry qualification requirements. Low start-up costs and continuous influx of new businesses. In addition to the traditional cross-border participants, small and medium-sized enterprises and even small workshops and individuals are actively involved. According to the data of Wisdom Research Consulting, 60.3% of sellers in China's export cross-border e-commerce will have annual sales of less than USD 5 million in 2021, and the market concentration is low. In the export cross-border e-commerce market environment with small sales and a large number of sellers, it is easy to trigger low-level competition, and price "fighting" becomes one of the main selling points, while low price is often accompanied by low quality, and low quality often gives rise to counterfeit and shoddy products, especially before the implementation of the E-Commerce Law in 2019, export cross-border e-commerce "barbaric

growth," breeding the wind of counterfeiting, and selling counterfeit goods, promoting "bad money expelling good money"

(2) *Differences in Commodity Quality Standards and Inspection Scales*. Cross-border export commodities face the problem of applicability of quality standards. China's requirements for commodity quality, safety, health, environmental protection, labeling, and other aspects of the target market countries, there are differences, or even significant differences. Countries on commodity-related standards or technical specifications requirements are also inconsistent. Lack of regulations and institutional support for cross-border export commodity regulation. In 2022, the Ministry of Commerce and other departments have begun to study policy initiatives to facilitate the return and exchange of goods for cross-border e-commerce exports

(3) *A Unified Quality Inspection and Supervision Platform Has Not Been Established*. Cross-border e-commerce trade is fragmented, with small batches, lots, a wide range of sourcing channels, and diverse sales patterns. Export cross-border e-commerce orders fragmentation, inspection and quarantine departments are difficult to implement the inspection in accordance with the provisions of the current "Import and Export Commodity Inspection Law," making the risk of commodity quality and safety significantly increased. The national unified export commodity quality supervision and management platform has not been established, no full-caliber data. Cross-border e-commerce platforms have not been fully docked to the inspection and quarantine information management system, making the risk assessment of cross-border goods and supervision effect is affected to a certain extent, fake, defective products can take advantage of "transformed" genuine products. Some e-commerce platforms are not strict in the review of sellers, supply chains, and suppliers. Illegal merchants from commodity packaging to invoices, from anticounterfeit signs to logistics and other forgery chain, increasing the risk of commodity quality

(4) *Commodity Traceability System Is Not Perfect*. Commodity traceability is difficult, and counterfeit goods are easy to flourish. According to the traditional process, the export of cross-border e-commerce from the purchase to sales that are links may appear fake goods. Some e-commerce companies are from the brand distributor to buy goods, the source of goods is not formal, and there may be counterfeit goods. Commodities cannot be traced, but also increased the difficulty of recovery. The problem has drawn the attention of the AQSIQ, which issued a document in 2015 to build a quality traceability system for cross-border e-commerce and then issued a document in 2017 to build a unified traceability information platform. Some localities are already taking action, but a unified national traceability system for export goods has not yet been established. In 2018, Shenzhen Customs established a traceability system for cross-border e-commerce commodities; in 2019, Fuzhou Customs' global quality traceability system went online; in 2020, the Guangdong Provincial Department of Commerce issued a document to support the construction of a traceability system for import and export commodities

(5) *The Awareness of Trademark and Other Intellectual Property Rights Protection Is Not Strong*. The importance of intellectual property rights to cross-border export commodities is self-evident. The weak awareness of intellectual property rights of some enterprises, coupled with the lack of understanding of patents of competing products, has led to an increased risk of intellectual property disputes. According to customs statistics, customs seized 17,800 batches and 1,995,700 pieces of suspected infringing goods of cross-border e-commerce in 2021, mainly infringing trademark rights, which accounted for 23.25% and 18.11% of enforcement in noncargo channels, respectively, almost doubled from 11.69% and 9.93% in 2020. Commodity trademark use is not legal, noncompliance, logo mark, and other packaging are not qualified and can damage the quality of goods. Cross-border e-commerce is borderless, and the flow of cross-border goods may pass through multiple countries or regions. Some enterprises have infringement violations, production, and sale of counterfeit and shoddy goods, and other illegal and noncompliant behaviors are contrary to intellectual property protection. The incidents of Amazon blocking and Paypal freezing accounts show that solving the problems of legality and compliance has become the top priority for export cross-border e-commerce

4.3. Countermeasure Suggestions for the Development of Cross-Border E-Commerce

(1) *Improve Industry Self-Regulation and Management Ability, and Enhance the Quality of Goods*. Play the role of self-regulatory function of industry organizations and strengthen the construction of self-regulatory capacity of export cross-border e-commerce industry. Industry organizations can advocate industry integrity commitment system, implement industry access system, etc., set up role models, summarize and promote experience, strengthen discipline, strengthen self-discipline through collective action, keep quality, and create a benign ecology. At present, the national organization of cross-border e-commerce industry has not yet been established, and the head enterprises of export cross-border e-commerce should reflect the industry's role, shoulder social responsibility, and promote

the establishment of a national industry organization. At present, it can play the role of industry organizations such as the Cross-border E-Commerce Working Committee of the Chinese Institute of Electronics, provincial and municipal cross-border e-commerce industry associations and chambers of commerce in industry self-regulation, and urge e-commerce enterprises to improve the quality of goods. In addition, we can learn from the operation mode of the American Chamber of Commerce and set up chambers of commerce in foreign countries to provide members with foreign laws and regulations, policy consultation, agent intellectual property rights and dispute handling services, and assist members in applying for and protecting intellectual property rights abroad

(2) *Strengthen the Protection of Intellectual Property Rights and Guarantee the Quality of Goods*. Intellectual property rights compliance is a necessary and urgent requirement for China's export cross-border e-commerce. Not to infringe, actively defend rights, and use intellectual property legally and compliantly, export cross-border e-commerce can develop healthily. Some enterprises do not have a strong awareness of intellectual property protection, are not familiar with overseas laws and judicial practice, and do not know enough about the risk of losing overseas disputes. In addition to establishing their own legal awareness, e-commerce platforms should also focus on reviewing and evaluating the IPR professional capacity of sellers, strengthening the protection of trademarks and other IPR, and encouraging the creation of independent brands. As intellectual property rights have a strong regional, the intellectual property rights obtained in China in other countries is not able to get the relevant recognition, so China's enterprises import and export at the same time, to timely report to the customs part of the relevant intellectual property rights to get the relevant protection. Of course, when exporting products with high technological content, enterprises must choose carefully and must apply for patents and trace and protect the relevant intellectual property rights under the support of local laws and policies. Know in advance the market targeted by the enterprise, whether it has intellectual property protection and the degree of protection or even relevant patent knowledge, are to learn, take risk prevention measures, and can ask local lawyers and other professionals as legal agents to prevent infringement

(3) *Build a Commodity Traceability System Supported by Quality Inspection Agencies*. Commodity quality is the lifeline for the healthy development of export cross-border e-commerce. Enterprises are the core of commodity quality traceability system, and in order to make consumers buy with confidence, e-commerce platforms should establish a commodity traceability system with the participation of quality inspection agencies. Sellers, suppliers, and manufacturers voluntarily access the traceability system and apply for testing and certification in order to trace the source. The "GBI Global Selection Platform" is a government-enterprise service platform jointly established by the China Academy of Inspection and Quarantine Science and other institutions under the guidance of the China Association of Business Economics, and its third-party traceability system "Global Commodity Traceability System" is authoritative, credible, and representative. The system adopts "Inspection and Quarantine Traceability" anticounterfeit traceability mark + QR code and other technologies to achieve the traceability of goods. After connecting to the system, the code is assigned to the certified goods, and one thing is one code. Consumers can scan the QR code of commodity package and compare the code to identify the authenticity and inquire about the quality information such as commodity and brand name, market entry time, and commodity source. Access to the system of goods certified to become quality assured products, not only to reduce the cost of testing enterprise products, shorten the testing process, effective prevention of product forgery but also access to multichannel supply chain services, selected for the platform's international brand recommendation directory can enter more than 200 countries procurement platform. At present, the system has been piloted in Shandong Province, Yunnan Province, and other places

(4) *Improve Credit Evaluation Management*. The e-commerce platform can refer to AEO certification, against the national standards for credit evaluation norms for merchants on cross-border e-commerce platforms, and sellers' credit evaluation management. The collection of relevant data is reflecting the credit information of the seller, the data into the corresponding score, the total score as a credit and risk evaluation grading basis, and the development of incentives and penalties, according to the score of regular upgrading, supplemented by withdrawal and elimination mechanism. Credit and risk evaluation level in the e-commerce platform, as a reference basis for consumers to buy goods, to force sellers to strengthen control of the source of goods, strict quality of goods

(5) *Play the Role of Consumer Supervision of the Quality of Goods*. The E-commerce Law, "supervision and management of network transactions" requires e-commerce enterprises to establish a way for consumers to evaluate goods. Consumer supervision is an external factor to improve the quality of goods, but also one of the effective ways. Consumers have a close relationship with the quality of goods, and feedback information on the quality of goods is

direct and efficient. E-commerce platforms should ensure smooth channels for consumers to evaluate commodities, develop a perfect information feedback incentive mechanism, encourage consumers to evaluate commodity quality and other situations, provide timely feedback, and make regular return visits to promote quality supervision through consumer feedback on commodity quality in order to improve the quality of exported cross-border commodities

5. Conclusion

The e-commerce platform is responsible for checking and supervising the platform commodity information, focusing on the implementation of this main responsibility, analyzing its causes, and choosing the corresponding methodological analysis countermeasures, which has wide practical significance and positive contemporary significance and is conducive to promoting the healthy development of China's export cross-border e-commerce ecology. Based on the perspective of promoting the high-quality development of cross-border e-commerce, this paper constructs a multiple linear regression model between e-commerce platforms and platform sellers regarding the inspection of commodities and the provision of commodity quality, studies the strategies chosen by each of the two sides of cross-border e-commerce game subjects under various possible scenarios, analyzes the relevant factors affecting their strategy choices, and proposes corresponding countermeasures for e-commerce enterprises.

Therefore, this paper studies the analysis of multiple linear regression algorithm on the factors of high-quality development of cross-border e-commerce, starting from the multiple linear regression model, and conducts an in-depth study of the current situation to analyze the problems: first, the entry threshold of cross-border e-commerce is relatively low; second, there are differences in commodity quality standards and inspection scales; again, a unified quality inspection and supervision and management platform has not been established; again, the commodity traceability system is not; finally, the awareness of trademark and other intellectual property protection is not strong. And a profound study of the problem and put forward countermeasures to promote the high-quality development of cross-border e-commerce: first, improve the industry's self-regulation and management ability to improve the quality of goods; second, strengthen the protection of intellectual property rights to protect the quality of goods; again, build a commodity traceability system supported by quality inspection agencies; and finally, play the role of consumer supervision of commodity quality.

Data Availability

The dataset is available upon request.

Conflicts of Interest

The author declares no conflicts of interest.

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Retraction

Retracted: Determination of Evidence Weights Based on Convolutional Neural Network for Classification Problem

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] S. Xu, Y. Hou, X. Deng, P. Chen, and S. Zhou, "Determination of Evidence Weights Based on Convolutional Neural Network for Classification Problem," *Journal of Sensors*, vol. 2022, Article ID 1616401, 8 pages, 2022.

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Research Article

Determination of Evidence Weights Based on Convolutional Neural Network for Classification Problem

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The weighted average is an efficient way to address conflicting evidence combination in the Dempster-Shafer evidence theory. However, it is an open issue how to determine the evidence weights reasonably. Although many traditional conflicting evidence combination solutions based on evidence distance or entropy have been put forward, the evidence weights are determined with a single aspect, and no comprehensive consideration of other useful information affects the weights. Thus, it does not ensure that determination of weights is the most reasonable. By introducing deep learning into conflicting evidence combination, this paper proposes a comprehensive method for determining the evidence weights based on a convolutional neural network. Taking the evidence as the network input and the corresponding weight as the output, it utilizes convolutional neural network to fully mine potentially useful information that affects the evidence weights, in order to determine the weights comprehensively. Additionally, we define a weight loss function. The weights are continuously optimized through back propagation and achieve the optimal when the weight loss function value is the minimum. Classification experimental results demonstrate that the proposed method outperforms traditional ones based on evidence distance or entropy and can be flexibly extended to other application fields as a decision-making fusion method.

1. Introduction

In practical applications, information from different sources is often uncertain, inconsistent, and vague [1]. How to deal with uncertain information effectively is an open problem. Several mathematical theories have been discussed for solving this problem, such as Bayesian theory [2], fuzzy set theory [3, 4], Dempster-Shafer (D-S) evidence [5, 6], possibility theory [7, 8], D-numbers [9, 10], Z-numbers [11, 12], rough set theory [13, 14], and fractal theory [15, 16]. Especially D-S evidence theory, as a rational and effective method for dealing with uncertain information, has the following three advantages. First, it does not require prior probabilities or satisfy probability additivity compared with Bayesian theory. Secondly, information from different experts and data sources can be fused by Dempster's combination rule [17] to obtain more reasonable results. Thirdly, it can describe uncertainty more flexibly and conviently than other mathematical theories. Therefore, it has been widely applied to classification [18, 19], risk evaluation [20, 21], fault diagnosis [22, 23], decision-making [24, 25], and so on.

However, Zadeh [26] pointed out that evidence combination would produce counterintuitive results, when there is a conflict between evidences. To overcome this defect, scholars have conducted in-depth research and proposed various improved methods. In general, the existing methods can be divided into two categories. One is to modify Dempster's combination rule; the other is to modify the original evidence.

For the first class, some scholars point out that conflicting information is lost in the process of evidence combination. So the key to modifying Dempster's combination rule is how to allocate the conflict, that is, to which subset the conflict is allocated and in what proportion. Smets et al. suggest that the conflict should be allocated to empty set [27]. Lefevre et al. propose a novel modified approach which proportionally assign the conflict information to the focal element sets [28]. Smardndache et al. propose the conflicting

proportional distribution rule named PCR3 [29]. The method of modifying Dempster's combination rule can solve the conflict problem to a certain extent, whereas the drawback of this method is that the good performance is destroyed, like commutativity and associativity. So this paper focuses on the second method.

For the second class, the initial evidences are corrected with the weights to obtain the weighted average evidences. Then, the weighted average evidences are fused by using Dempster's combination rule to get reasonable results. Therefore, the weighted average is an efficient way to address conflicting evidence combination. Nevertheless, this is a challenging problem how to determinate the evidence weights reasonably. For this reason, scholars have proposed some novel methods. Deng defined a new uncertainty measure Deng entropy to construct the weight coefficient bodies of evidence [30]. Tang et al. propose a weighted belief entropy which measure the uncertainty by using the information of the mass function and the scale of the FOD, in order to obtain the weight of evidence [31]. Qin et al. use a novel belief entropy which is an improved version of Dubois–Prade entropy and Nguyen entropy, to allocate the weights of evidence [32]. Yan et al. use an improved belief entropy based on Deng entropy to determine the weights of evidence [33]. Liu et al. propose a novel weighted evidence combination based on MaxDiff distance [34]. Han et al. introduced the concept of evidence support based on the Jousselme distance function and took a weighted average of all the evidences [35]. Liu et al. design an improved weighted evidence combination method by combining probability distance and conflict coefficient [36]. Xiao generalizes the traditional Jousselme distance to the complex evidence distance to measure the conflicts of complex the basic probability assignment (BPA) functions [37], and used it as a weighted factor to revise the original evidence [38]. The above methods only use entropy or distance information to determine the weights from the perspective of uncertainty and evidence conflict. The disadvantage is that determination of the weights is rather one-sided, and no comprehensive consideration of other useful information that affects the weights, such as importance, reliability, relativity, and unknown information hidden within or between evidence. Consequently, these methods based on evidence distance or entropy do not ensure that determination of weights is the most reasonable.

In view of the powerful adaptive learning and information mining capabilities of convolutional neural networks (CNN), we introduce deep learning into conflicting evidence combination and propose a comprehensive method for determining the evidence weights based on a CNN to solve this problem. Taking the evidence as the network input and the corresponding weight as the output, we define a weight loss function. Through back propagation, update the network parameters and fully mine potentially useful information that affects the weights. So the evidence weights are determined comprehensively and optimized continuously, and finally achieve the optimal when the weight loss function value is the minimum. Compared with traditional algorithms based on evidence distance or entropy, the proposed method makes the determination of weights more reasonable and can achieve higher accuracy rate in classification application.

In summary, the primary contributions in this study are summarized as follows:

(i) Different from traditional methods, this paper proposes a comprehensive method for determining the evidence weights based on CNN

(ii) The evidence weights are not determined for a certain aspect related to the evidence and can reflect the relationship among evidence comprehensively

(iii) Compared with the traditional algorithms based on evidence distance or entropy, the proposed method can achieve higher accuracy rate in classification application

The rest part of this paper is organized below. Section 2 introduces some relevant basic theoretical knowledge about the D-S evidence theory. Section 3 proposes a comprehensive method for determining the evidence weights based on a CNN and introduces overview of proposed method, CNN architecture, and the weight loss function. Section 4 presents the classification application of the proposed method, and analyzes and discusses its results. Conclusions are in Section 5.

2. D-S Evidence Theory

D-S evidence theory is a reasoning system theory first put forward by Dempster in 1967 and further developed by Shafer in 1976. Compared with Bayesian probability theory, it can more flexibly and effectively deal with uncertain information without prior probabilities. Thus, it is an extension of Bayesian probability theory. In the frame of D-S evidence theory, Dempster's combination rule can be used to combinate evidences collected from different sources, which satisfies the commutative and associative laws. Some basic concepts about evidence theory is introduced as follows.

Definition 1 (Frame of discernment). Assuming that Θ is a set of mutually exclusive and exhaustive elements $F_i (i = 1, 2, 3, 4, \cdots, N)$, and it can be defined as [31].

$$\Theta = \{F_1, F_2, F_3, F_4, \cdots, F_N\}, \tag{1}$$

where Θ is called the frame of discernment (FOD), and F_i is named single-element proposition or subset. We define 2^Θ as a power set which contains 2^N elements and can be described as

$$2^\Theta = \{\varnothing, F_1, \cdots, F_N, \{F_1, F_2\}, \{F_1, F_3\}, \cdots, \Theta\}, \tag{2}$$

where $\varnothing$ is an empty set in Eq.(2).

Definition 2 (The basic probability assignment function). The BPA function m is also called mass function and is

defined as a mapping of the power set 2^{Θ} to [0,1] [33].

$$m : 2^{\Theta} \longrightarrow [0, 1], \tag{3}$$

which satisfies

$$\begin{aligned} m(\varnothing) &= 0 \\ 0 \le m(A) &\le 1, \\ \sum_{A \subseteq \Theta} m(A) &= 1, \end{aligned} \tag{4}$$

where mass function $m(A)$ represents the degree of support to A, and A is called focal element or proposition. The mass function $m(\varnothing)$ is equal to 0 in classical D-S evidence theory.

Definition 3 (Dempster' s combination rule). In D-S evidence theory, two BPAs can be combined with Dempster' s rule of combination, defined as followers [17]:

$$m(A) = (m_1 \oplus m_2)(A) = \frac{1}{1 - K} \sum_{B \cap C = A} m_1(B) m_2(C), \tag{5}$$

in which

$$K = \sum_{B \cap C = \varnothing} m_1(B) m_2(C), \tag{6}$$

where $\oplus$ represents Dempster's combination rule. K is called conflict coefficient, and it has values between 0 and 1. The bigger K is, the more conflict between two evidences is.

Definition 4 (Weighted average evidence). Suppose that $m_1, m_{2,\cdots,} m_n$ is the evidence collected from different data sources, and $w_1, w_{2,\cdots,} w_n$ is the corresponding weights of evidence. Then, original evidence can be modified by the weight to obtain the weighted average evidence:

$$m' = \sum_{i=1}^{n} w_i \times m_i, \tag{7}$$

in which

$$\sum_{i=1}^{n} w_i = 1. \tag{8}$$

The weight w_i is equal to 1, indicating that the corresponding evidence m_i is a piece of information that can be fully reliable. Relatively small weight indicates that it plays little role in evidence combination, and the weight is equal to 0, which means that it can be discarded directly.

3. Determination of Evidence Weights Based on Convolutional Neural Network

3.1. Overview of Proposed Method. To determine the evidence weights more comprehensively and reasonably, we propose a novel method for determining the evidence weights based on a CNN. First, we take initial BPAs, namely, evidences, as the input of CNN, and the corresponding weights are defined as output. Then, we define a weight loss function and the weights are continuously optimized through back propagation. Finally, the optimal evidence weights can be obtained when the weight loss function value is the minimum.

3.2. CNN Architecture. In this section, a CNN is introduced, which consists of a convolution layer, two fully connected layer, and a softmax function output layer, as shown in Figure 1. The initial BPA m_i which is a $1 \times N$ vector is defined as the input to the network. N represents the number of elements within FOD, namely, the number of categories in the dataset. Before a convolution operation, these input evidence vectors are combined into $k \times N$ matrix. After that, we choose $k \times k$ convolution kernels to mine the potential information contained within and between the evidences. Finally, the outputs of two fully connected layer are fed into a softmax function output layer, in order to produce probability weights corresponding to the input evidences. The size of the convolution kernel and softmax function output lay depends on the amount of input evidences.

3.3. The Weight Loss Function. During the conflicting evidence combination, the input evidence m_i is modified by the output weight w_i:

$$m' = \sum_{i=1}^{k} w_i \times m_i, \tag{9}$$

where w_i ranges from 0 to 1 and m' is the weighted average evidence. After the input evidences is corrected, the final combination results $\hat{y}$ can be got by using Dempster's combination rule to combine the weighted averaged evidence m' for $k - 1$ times:

$$\begin{aligned} \hat{y}(A) &= \left(m' \oplus m' \oplus \cdots \oplus m'\right)_{k-1}(A) \\ &= \frac{\sum_{A_{1,\cdots,} A_k \subseteq \Theta_{A_1 \cap \cdots \cap A_k = A}} m'(A_1) \cdots m'(A_k)}{1 - \sum_{A_{1,\cdots,} A_k \subseteq \Theta_{A_1 \cap \cdots \cap A_k = \varnothing}} m'(A_1) \cdots m'(A_k)}, \end{aligned} \tag{10}$$

where $\oplus$ represents Dempster's combination rule which satisfies the polarizability. It means that the total belief degree of a single element increases and the total belief degree of multiple elements decreases when multiple identical evidences are fused. In addition, provided the basic probability value of a single element of the evidence is the largest, the basic probability value of this single element is still the largest when two identical evidences are combinated by Dempster's combination rule.

The output weights corresponding to the input evidences should be determined according to the following rules: (a) The higher the relativity between the input evidence vector and the true category one-hot vector is, the larger its corresponding output weight will be. (b) The higher the conflict

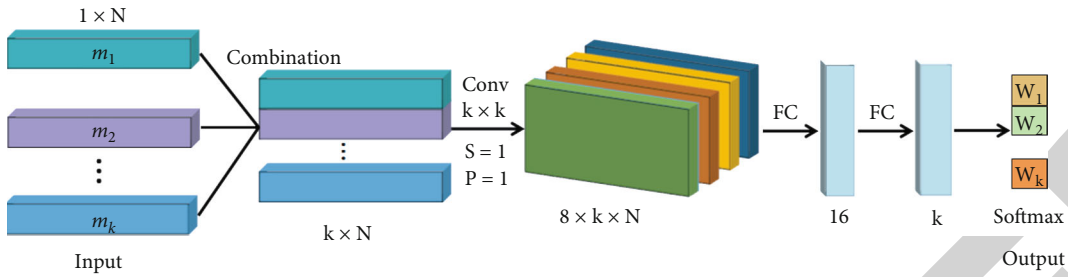

Figure 1: Architecture of the proposed method (S=Stride, P=Padding).

between the input evidence vector and the true category one-hot vector is, the smaller its corresponding output weight will be, that is, the evidence will contribute little to the combination results.

Based on the above rules, we define a weight loss function L_w as the sum of the cross entropy between all pairs of y_i and $\hat{y}_i$ to obtain the optimal evidence weights:

$$L_w = -\frac{1}{n}\sum_i y_i \ln \hat{y}_i. \tag{11}$$

In the above formula, n represents the number of training samples. $y_i \in R^{1\times N}$ is the true category one-hot vector. $\hat{y}_i$ is the final combination result. In the process of seeking the minimized loss function value L_w, when L_w does not meet the condition, network parameters are constantly updated and output weights are continuously optimized through feedback. Since Dempster's combination rule satisfies the polarizability, the weight of normal evidence will be larger and larger, and the weight of conflicting evidence will be smaller and smaller. When L_w satisfies the condition, namely, reaches the minimum value, the output weights achieve the optimal. The flow of the evidence weights optimization is showed in Figure 2.

4. Experimental Results and Discussion

4.1. Experimental Setup. This section gives the introduction of UCR datasets, and the datasets generation, parameter settings, and experiment procedure are presented.

4.1.1. UCR. UCR datasets are obtained from UCR time series data mining archive (http://www.cs.ucr.edu/eamonn/timeseriesdata/) which is a publicly available and real-world time series dataset and has always been used for classification. To verify the classification ability of the proposed method, we conduct the experiments on 6 UCR datasets, including ElectricDevices (ED), UWaveGestureLibraryY (UY), UWaveGestureLibraryZ (UZ), CricketX, CricketY, and CricketZ. ElectricDevices consists of 7711 test samples and contains 7 categories. Both UWaveGestureLibraryY and UWaveGestureLibraryZ consist of 3582 test samples, and contain 8 categories. Each of CricketX, CricketY, and CricketZ consists of 390 test samples and contains 12 categories.

4.1.2. Datasets Generation. UCR datasets are the original data containing attribute information and cannot be directly used as the input of the model which determines the evidence weights. Therefore, to obtain the initial BPAs from these datasets, we utilize the BPA generation method that is the probability output of neural network [39]. Each class in UCR test set can be regarded as one element within the frame of discernment $\Theta = \{F_1, F_2, F_3, \cdots, F_N\}$. These elements are exclusive and independent. We take the probability output of a UCR test set on a single neural network as BPAs. Since the MultiLayer Perceptron (MLP), Fully Convolutional Network (FCN), and Residual Network (ResNet) are defined as the standard baseline in the time series classification [40], these three single neural network are used to generate BPAs in this paper. A test sample will generate three pieces of evidence on three single neural networks. For the same test set, the prediction accuracy rates obtained on three single neural networks which differ in structure and performance will certainly not be all the same, so the BPAs generated by three neural networks will be different. In other words, there is a conflict between the BPAs. Hence, it is reasonable that we use the probability output of a test set on the MLP, FCN, and ResNet as a dataset for conflicting evidence combination research. However, the BPAs generated by the neural network only contains singleton element proposition. Therefore, the artificial simulation method is adopted to obtain the BPAs which contain multi-element propositions. The artificial synthesis dataset is formed by manually collecting classical numerical examples from papers with conflicting evidence fusion. It consists of 21 training samples and 42 test samples. Each sample in this dataset contains 5 pieces of evidences, and 3 categories which are denoted by $\{F_1, F_2, F_3\}$. Assuming that the five pieces of evidence in the first sample are defined as $m_{11}(\cdot)$, $m_{12}(\cdot)$, $m_{13}(\cdot)$, $m_{14}(\cdot)$, and $m_{15}(\cdot)$, the BPAs are shown as follows.

$$\begin{aligned}
&m_{11}(F_1) = 0.41, \quad m_{11}(F_2) = 0.29, m_{11}(F_3) = 0.30\\
&m_{12}(F_2) = 0.90, \quad m_{12}(F_1, F_3) = 0.10\\
&m_{13}(F_1) = 0.58, \quad m_{13}(F_2) = 0.07, m_{13}(F_1, F_3) = 0.35\,.\\
&m_{14}(F_1) = 0.55, \quad m_{14}(F_2) = 0.10, m_{14}(F_1, F_3) = 0.35\\
&m_{15}(F_1) = 0.60, \quad m_{15}(F_2) = 0.10, m_{15}(F_1, F_3) = 0.30
\end{aligned} \tag{12}$$

4.1.3. Parameter Settings. The proposed method is trained in

TensorFlow using back propagation with Adam to update the network. The learning rate of Adam is 0.001, β_1= 0.9, β_2= 0.999, and ε=1e-8 [40]. The second type of dataset is randomly divided into the training set and test set according to the ratio of 2 : 8, and the number of training sets is 1542, 716, 716, 78, 78, and 78, respectively. Therefore, the batch sizes of 13 and 19 are opted. Since the proposed model is not complicated, we set the number of epochs to 2000.

4.1.4. Experiment Procedure. This paper uses two different types of datasets as database to introduce the application of the proposed method in classification. A detailed description of the procedure is depicted as follows:

(1) The first type of dataset containing multi-element propositions is derived from the artificial synthesis dataset. Each sample in this dataset contains 5 pieces of evidences. Correspondingly, the size of the convolution kernel and the softmax function output lay is 5. The second type of dataset contains only single-element propositions. It is derived from the predicted results of 6 UCR test sets on the MLP, FCN, and Resnet. One sample in these test sets will produce 3 pieces of evidences. The second type of dataset is randomly divided into the training set and test set according to the ratio of 2 : 8. In order to verify the robustness of model, each dataset is divided randomly for 5 times, and the same random state is repeated for 5 times to record the average value

(2) Get the optimal evidence weights when the proposed cross entropy loss function value satisfies the minimum

(3) Original evidences are corrected with the weights to obtain the weighted average evidences

(4) Then, the weighted average evidences are fused by using Dempster's rule to get the final combination evidences

(5) The predicted category is determined by the final combination evidence. As to the first class, the category corresponding to the maximum value in the singleton element is the predicted result. As to the second class, the category corresponding to the maximum probability value is the predicted result

To further verify the feasibility of the proposed method, we have compared with four well-known traditional methods, namely, classical D-S theory method [17], two belief entropy-based methods [30, 33], and a distance-based method [35]. Accuracy and processing time for classification are adopted as the evaluation index.

4.2. Results and Discussion

4.2.1. Classification Results. The classification accuracy on the two types of datasets are shown in Tables 1 and 2, respectively. According to experimental results, we can draw the following conclusions: (a) For the first type of dataset,

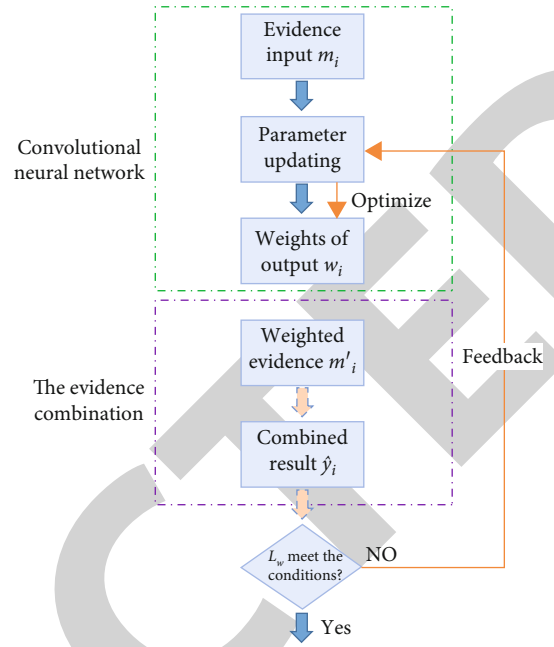

Figure 2: Flow of the evidence weights optimization.

Yan et al.'s method, Han et al.'s method, and our proposed method similarly achieve the highest classification accuracy of 97.6%, while Dempster's has a classification accuracy of 64.2% and Deng's method has a classification accuracy of 95.2%. It indicates that the proposed method retains competitive performance. (b) The classification accuracy of the proposed method is always higher compared with a single best-performing neural network classification algorithm, and the average improvement on the second type of datasets is 2.47%, 4.20%, 1.59%, 0.74%, 3.21%, and 1.73%, respectively. It illustrates that the proposed method which combines the predicted results of three single neural networks can obtain better classification results than a single network. In addition, proposed method is to get the final decision by fusing multiple prediction results, which is regarded as the decision level fusion, so it can be flexibly extended to other application fields. (c) For the same dataset, the classification accuracy of the proposed method under five random states has little fluctuation. It proves the robustness of our model. (d) Compared with classic traditional method, two belief entropy-based traditional methods and a distance-based traditional method on the second type of datasets, the classification accuracy of the proposed method is the highest, and the total average improvement is 4.06%, 10.11%, 10.11%, and 16.19%, respectively. These indicate that the determination of weights based on CNN is more reasonable, which proves the validity of proposed method.

4.2.2. Processing Time Results. The experiment of processing time is implemented on an ordinary personal computer with a Intel Core i7-9750H CPU at 2.60 GHz and 8 GB RAM. According to the time complexity calculation presented in [41], the time complexity of four traditional algorithms is $O(x \times 2^n)$, $O(x \times 2^{2n})$, $O(x \times 2^{2n})$, and $O(x^2 \times 2^n)$, where x and n represent the number of evidences and elements in

Table 1: The classification performance comparison on the first type of dataset.

Dataset	Dempster [17]	Deng[30]	Yan and Deng [33]	Han et al. [35]	Proposed method
Artificial synthesis	64.2%	95.2%	**97.6**%	**97.6**%	**97.6**%

Table 2: The classification performance comparison on the second type of datasets.

Dataset	Random state	MLP	FCN	ResNet	Dempster [17]	Deng [30]	Yan and Deng [33]	Han et al. [35]	Proposed method
ED	1	59.1%	69.2%	74.1%	71.4%	61.6%	61.6%	37.9%	**76.5**%
	2	59.2%	68.9%	74.2%	71.6%	61.8%	61.8%	37.3%	**76.4**%
	3	59.6%	69.6%	74.0%	71.9%	62.0%	62.0%	37.7%	**77.1**%
	4	59.8%	69.3%	74.2%	71.6%	62.3%	62.3%	37.2%	**76.7**%
	5	59.3%	69.4%	74.3%	71.4%	62.2%	62.2%	37.1%	**76.4**%
UY	1	68.1%	60.0%	64.1%	71.9%	62.8%	62.8%	70.4%	**72.4%**
	2	69.2%	59.9%	64.6%	72.0%	62.6%	62.6%	71.4%	**73.5%**
	3	68.0%	59.6%	64.4%	71.3%	62.5%	62.5%	71.1%	**72.3%**
	4	69.1%	60.3%	65.0%	72.5%	63.3%	63.3%	71.4%	**73.7%**
	5	69.2%	59.9%	64.4%	72.5%	63.1%	63.1%	71.2%	**72.7%**
UZ	1	68.3%	69.6%	75.8%	76.6%	70.1%	70.1%	64.5%	**77.4%**
	2	69.5%	69.4%	75.8%	76.9%	70.5%	70.5%	64.4%	**77.5%**
	3	68.8%	69.3%	75.8%	76.6%	70.2%	70.2%	64.0%	**77.7%**
	4	69.1%	69.9%	75.5%	76.4%	70.5%	70.5%	64.2%	**76.5%**
	5	68.4%	69.4%	75.2%	76.3%	70.4%	70.4%	64.2%	**76.9%**
CricketX	1	56.0%	79.1%	78.2%	72.1%	74.0%	74.0%	63.4%	**80.4%**
	2	54.8%	79.8%	78.5%	73.0%	72.7%	72.7%	63.4%	**80.4%**
	3	58.9%	80.7%	78.8%	73.7%	74.3%	74.3%	62.1%	**80.8%**
	4	57.0%	81.0%	79.4%	74.3%	73.7%	73.7%	62.1%	**82.1%**
	5	58.9%	80.7%	80.1%	73.0%	74.6%	74.6%	63.1%	**81.4%**
CricketY	1	58.6%	78.2%	78.5%	76.9%	68.9%	68.9%	70.1%	**82.6%**
	2	60.2%	79.4%	80.1%	77.8%	69.8%	69.8%	69.5%	**83.4%**
	3	60.8%	79.1%	79.4%	76.6%	70.1%	70.1%	69.8%	**83.5%**
	4	60.2%	78.5%	79.8%	76.6%	68.5%	68.5%	69.2%	**81.6%**
	5	57.6%	78.2%	79.1%	75.0%	68.5%	68.5%	70.8%	**81.9%**
CricketZ	1	61.2%	79.4%	80.1%	78.2%	73.3%	73.3%	69.5%	**82.5%**
	2	60.2%	80.4%	79.4%	77.2%	73.0%	73.0%	70.1%	**81.4%**
	3	60.2%	81.0%	80.4%	79.4%	74.3%	74.3%	69.8%	**83.3%**
	4	60.5%	79.1%	80.4%	78.2%	73.7%	73.7%	70.5%	**82.6%**
	5	61.8%	80.1%	81.7%	79.4%	75.3%	75.3%	70.8%	**82.5%**

Table 3: The processing time of different approaches.

Dataset	Dempster [17]	Deng [30]	Yan and Deng [33]	Han et al. [35]	Proposed method	
					Training time (s)	Testing time (s)
ED	0.27	1.08	1.08	0.67	252.33	0.05
UY	0.14	0.59	0.59	0.35	117.43	0.02
UZ	0.14	0.59	0.59	0.35	117.68	0.02
CricketX	0.02	0.09	0.09	0.06	16.76	0.01
CricketY	0.02	0.09	0.09	0.06	16.59	0.01
CricketZ	0.02	0.09	0.09	0.06	17.17	0.01
Artificial synthesis	0.01	0.01	0.01	0.01	235.53	0.04

the FOD, respectively. The time complexity of Deng and Yan's algorithms is higher. For all datasets, we take the average processing time of 5 random states for comparison, and the results are illustrated in Table 3. The proposed method spends a lot of time in the training phase, but after training, the processing time of our approach is comparable to that of the other four methods.

5. Conclusion

In this paper, by introducing deep learning into conflicting evidence combination, we propose a comprehensive method for determining the evidence weights based on a CNN. Taking the evidence as the network input and the corresponding weight as the output, it utilizes CNN to fully mine potentially useful information that affects the evidence weights, in order to determine the weights comprehensively. Besides, the weights are continuously optimized through back propagation and achieve the optimal when the weight loss function value satisfies the minimum. The classification experimental results show that the proposed method makes the determination of weights more reasonable and obtains a higher classification accuracy compared with traditional ones based on evidence distance or entropy and can be flexibly extended to other application fields as a decision-making fusion method.

Data Availability

UCR datasets are obtained from UCR time series data mining archive (http://www.cs.ucr.edu/eamonn/timeseriesdata/).

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

In this research activity, all the authors were involved in the data collection and preprocessing phase, developing the theoretical concept of the model, empirical research, results analysis and discussion, and manuscript preparation. All authors have agreed to the published version of the manuscript.

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Retraction

Retracted: The Application of Multisensor Information Fusion Technology in Environmental Restoration

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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Research Article

The Application of Multisensor Information Fusion Technology in Environmental Restoration

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Multisensor information fusion technology is an advanced processing method that is different from classical data processing technology. Capability and operational accuracy, in order to make an effective comprehensive evaluation of environmental quality, the environmental monitoring system built by NB-IoT technology and sensor technology is used to conduct multisensor data fusion research on the collected environmental factors such as temperature, humidity, formaldehyde, PM2.5, and TVOC. At the same time, the two-level parallel fusion method is adopted to evaluate the environmental quality. Before data fusion, median filtering is used to eliminate abnormal data. Then, the Kalman filter algorithm is used to fuse multiple sets of similar sensors to obtain the best value of it. Finally, the fuzzy comprehensive evaluation method is used to fuse the different types of sensors at the decision-making level, in which the weight value is determined by the entropy method and the membership function is Gaussian. The different environment scenarios are tested by using the above algorithms, and the simulation results show that multisensor data fusion can obtain more abundant and effective environmental information, overcome the simplicity and limitation of single-factor sensor for environmental quality assessment, and improve the reliability and accuracy of the overall environmental quality assessment.

1. Introduction

With the rapid development of the global economy, China's economy has grown exponentially since the reform and opening up more than 40 years ago [1]. At the same time, behind the economic growth, China's environmental pollution problem is also "complimenting each other," and it is becoming more and more serious [2]. The main cause of environmental pollution is that the atmosphere contains a large amount of harmful substances [3]. In order to better realize the ecological sustainable development of the country, it is necessary to use advanced monitoring tools and environmental monitoring technologies in the process of monitoring, preventing, and governing the environment [4]. Therefore, in view of the current environmental pollution problem, it is urgent to increase the monitoring of the environment and actively develop the monitoring technology of the environment [5]. With the rapid development of the Internet of Things technology, environmental monitoring is also bred. Embed advanced Internet of Things technology in environmental monitoring, and use multisensor fusion technology to organize and analyze comprehensive and accurate data collected by various sensors. The purpose is to accurately find problems in the current environment and timely prevention and control to improve environmental monitoring quality and monitoring efficiency [6]. At present, western developed countries such as the United States and the United Kingdom already have relatively complete environmental monitoring systems [7]. The United States launched environmental satellites in the 1980s to determine the state of global environmental quality [8]. Japan

establishes automated ambient air monitoring bureau to monitor regional air quality. Our country launched two environmental and disaster monitoring satellites in 2008. The airborne atmospheric and water environment pollution monitoring system developed by Anhui Institute of Optics and Fine Mechanics, Chinese Academy of Sciences, realizes regional atmospheric environment monitoring. In the literature [9], the adaptive weighted fusion technology is used to monitor the soil environment. In the literature [10], the adaptive weighting algorithm and fuzzy neural network algorithm are used to monitor the environment. In [11], the weighted least squares method is used for multisensor fusion. Reference [12] uses the second-order adaptive weight particle filter method for multisensor information fusion. Reference [13] uses Bayesian method for data fusion. The soil and groundwater pollution situation in my country is severe. Only in the eastern plains and coastal areas, there are hundreds of thousands of potential pollution sites, many of which are organic pollution sites, especially organic solvent pollution such as chlorinated hydrocarbons and aromatic hydrocarbons.

The basic principle of multisensor information fusion (MSIF) technology is like the brain processing the information obtained by all sensing organs of the human body [14]. Unify and rationally utilize the capabilities of each sensor, reasonably allocate the computing units of each sensor, and comprehensively judge the validity and accuracy of the information [15]. The implementation of MSIF requires the installation of several similar or completely complementary sensors in multiple parts of the smart device to obtain single and incomplete information and then use information fusion algorithms to find possible potential connections among a large amount of data from different sensors [16]. Remove redundant information and form a complete system environment for accurate understanding [17]. Because of its unique advantages, it is widely used in the military field, economic field, robot intelligence field, medical field, etc. The method of information fusion is the most important part of multisensor information fusion [18, 19]. Due to the complexity and diversity of its application, the research content of information fusion is extremely rich, involving many basic theories, and the commonly used algorithm is Kalman filter, parameter template method, Bayesian inference, adaptive neural network, etc. The development of sensor technology has been relatively mature, and there are suitable sensor types for use in different environments, different types of data, and applications with different functions [20]. Most of the data acquired by the sensor is used to obtain the state of the system or to perceive the surrounding environment [21]. Nowadays, the mainstream environmental perception methods can be roughly divided into two types: image-based information perception and wave-based information perception according to the working principle of the sensor [22, 23]. On the basis of the first-level Kalman filter, in order to effectively and reasonably evaluate a variety of environmental factors, the fuzzy comprehensive evaluation method can avoid the limitation of a single sensor to evaluate the environmental quality.

In the multisensor information fusion technology, if all the sensors are configured with the standard time stamp, the coordinate systems of all sensors are transformed into absolute or relative coordinate systems. In order to get an accurate description of the environment, while using multiple sensors to work together, it is also necessary to transmit the collected information to the data fusion center [24]. After a series of data processing, a complete description can be obtained. Based on the general structure, multisensor information fusion can also be divided into three categories: centralized, distributed, and hybrid. Centralized fusion is to transmit the measurement information obtained by all sensors directly to the central processing unit for unified processing [25]. In this structure, if all sensors are configured with standard timestamps, the coordinate systems of all sensors are transformed into absolute or relative coordinate systems [26]. Based on the general structure, multisensor information fusion can also be divided into three categories: centralized, distributed, and hybrid. Centralized fusion is to transmit the measurement information obtained by all sensors directly to the central processing unit for unified processing. Rich raw information that can provide the most accurate information that other fusion layers cannot. The amount of sensor data that needs to be processed is huge, the processing cost is high, the time is long, and the real-time performance is poor. Raw data is easily polluted by noise.

In the past, the fusion of large amounts of data was mostly realized by offline processing after real-time storage. However, with the development of sensor technology, the measurement accuracy of sensors is getting higher. The environmental monitoring system designed in this paper combines Narrowband Internet of Things (NB-IoT) technology and two-level parallel fusion technology to evaluate environmental quality [27]. Before the first-level fusion, the median filter algorithm is used to remove abnormal data to improve the data accuracy, and then, the Kalman filter algorithm is used to perform the first-level fusion of the five environmental factors to provide accurate and effective data for the second-level fusion [28]. The second-level fusion uses the fuzzy comprehensive evaluation method to fuse the various sensor values after the fusion of the previous level at the decision-making level, which avoids the singleness of environmental quality monitoring and overcomes the shortcomings of inaccurate environmental evaluation by a single factor [29]. The multisensor fusion algorithm improves the accuracy of the Narrowband Internet of Things- (NB-IoT-) based environmental monitoring system and provides convenience for users to view environmental monitoring data on the platform in real time and understand the environmental conditions.

2. NB-IoT's Environmental Monitoring System Architecture

This paper uses STM32F103C8T6 as the main control chip and obtains the data collected by various sensor modules through the combination of software and hardware. Use NB-IoT technology to send a variety of sensor data to the

cloud platform, view monitoring data in real time through the cloud platform, extract data, and perform data fusion processing. Although information fusion technology has been gradually developed since the early 1970s, there is no universal algorithm that can satisfy all usage scenarios. According to the concept of algorithm, it is mainly divided into three categories: physical model, parameter-based model, and cognitive-based model. The rapid development of Internet of Things technology has brought vitality to environmental monitoring and injected new vitality. The environmental monitoring system designed by using the Internet of Things technology can effectively improve the real-time performance and effectiveness of the monitoring system, share the collected data and information with each other, and provide a strong guarantee for environmental monitoring [30]. Compress the provided raw data to reduce interference noise, which is more suitable for real-time processing. Feature vector combination classification is performed on related data before fusion. The entire environmental monitoring data is provided by the temperature and humidity sensor DHT22, the formaldehyde sensor ZE08-CH2O, the dust (PM2.5) sensor ZPH01, and the total volatile organic compound (TVOC) sensor KQM2008A, and the data is uploaded to China Mobile (OneNET) using NB-IoT technology, in which the hardware structure of the environmental monitoring system is shown in Figure 1.

The temperature and humidity sensor DHT22 uses single-bus communication to transmit 40-bit data including temperature and humidity integers, decimals, and parity. Compared with DHT11, the advantage is that the collection volume can reach decimal places, the response speed is fast, and the anti-interference ability is strong. It also applies special digital module acquisition technology to ensure its reliability and stability. Design verification functions in the software program to ensure the accuracy of the output data. Single-dimensional data fusion cannot meet applications in complex scenarios, and it also limits the capabilities of the system. The future development of multisensor data fusion technology should develop towards multitype sensors, multidimensional fusion, and multistrategy fusion to adapt to simple to complex application scenarios and improve system robustness and stability.

The formaldehyde sensor ZE08-CH2O is designed with electrochemical detection technology and built-in temperature compensation circuit with high stability and resolution less than 0.012 5 mg/m3. Adopt Universal Asynchronous Receiver Transmitter (UART) communication protocol, also output accurate data according to the check function. Dust sensor ZPH01 has extremely high sensitivity and long-term stability, among which the minimum particle output capacity of dust is 1 μm, the communication method is UART and equipped with calibration value. Total volatile organic compound (TVOC) sensor KQM2008A integrates 12-bit high-precision digital-to-analog conversion. The module uses Fourier transform and separation algorithm to suppress drift and improve accuracy and outputs accurate data through UART. Finally, the collected data is used multisensor fusion technology to evaluate the pros and cons of monitoring the environmental quality of the entire system. Multisensor fusion is a technology for data information calibration, correlation, identification, and estimation. The degree of information processing is divided into three levels from low to high: data-level fusion, feature-level fusion, and decision-level fusion. In order to better use the multisensor fusion technology, it is necessary to determine its fusion structure, and the basic fusion structure is divided into three types, which are serial fusion, parallel fusion, and hybrid fusion [31]. According to the type of fusion structure, combined with the way the environmental monitoring system designed in this paper collects data, the multisensor fusion algorithm model of the whole system is designed as a two-stage parallel fusion, and the fusion model is shown in Figure 2.

3. Homogeneous Sensor Fusion Algorithm

In order to make the overall fusion algorithm evaluate the environmental quality more accurately and meet the standards of multisensor data fusion technology, this paper will set up 5 environmental monitoring subsystems to obtain environmental data including temperature, humidity, formaldehyde, PM2.5, and TVOC, so before the first-level fusion process, a median filter function is added to each type of sensor. The purpose is to make each sensor improve the accuracy of the collected data on the premise of obtaining effective values and effectively overcome the fluctuation interference caused by accidental factors. Simple and intuitive weighted average algorithm is a way to directly manipulate the data source provided by the sensor and use the weighted average as the fusion value. The difference between data processing methods and classical methods in multisensor data fusion can be manifested in complex forms. And different information levels have different complex forms. Bayesian estimation is also a low-level data fusion method, which mainly combines static data collected by sensors according to the principle of probability. The Kalman filter itself is very dependent on the accuracy of its system model. If the state of the system and the measurement model are sufficiently accurate, then Kalman filtering can recursively provide the best estimate of the combined data in a statistical sense. While Kalman filtering is mainly used to fuse low-level real-time dynamic multisensor redundant data, this method uses the statistical features of the measurement model to recurse and determine the best fusion and data estimation in the statistical sense. Therefore, the first-level fusion will use the Kalman filter algorithm. Compared with the original data, the amount of information of the preprocessed data will be greatly reduced. The advantage of this is that it can effectively reduce the bandwidth requirements for information transmission. At the same time, the computational load of the fusion unit will be reduced so that more complex algorithms can be deployed without losing too much time. Kalman filter, also known as optimal autoregressive data processing algorithm, is a recursive estimation algorithm based on linear minimum variance of state variables. If the system has a linear dynamic model and the error between the system and the sensor conforms to a Gaussian white noise model, then Kalman filtering will provide the only statistically optimal estimate for the fused data. Due

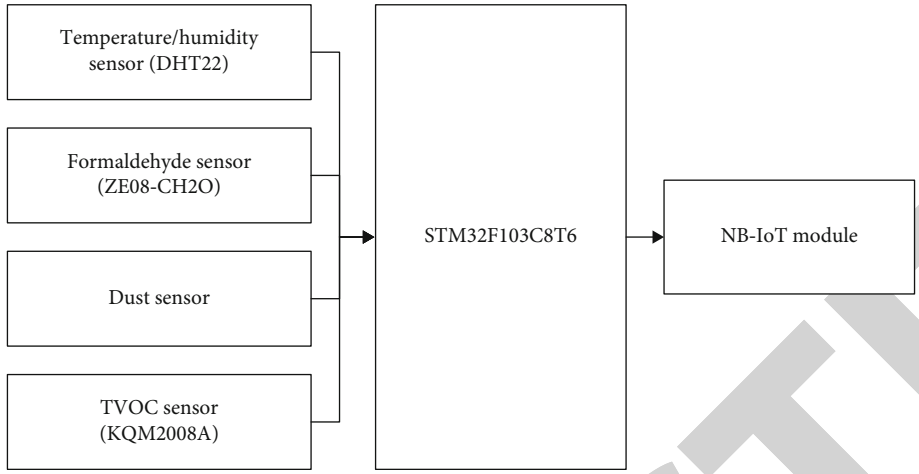

Figure 1: Hardware structure diagram of the environmental monitoring system.

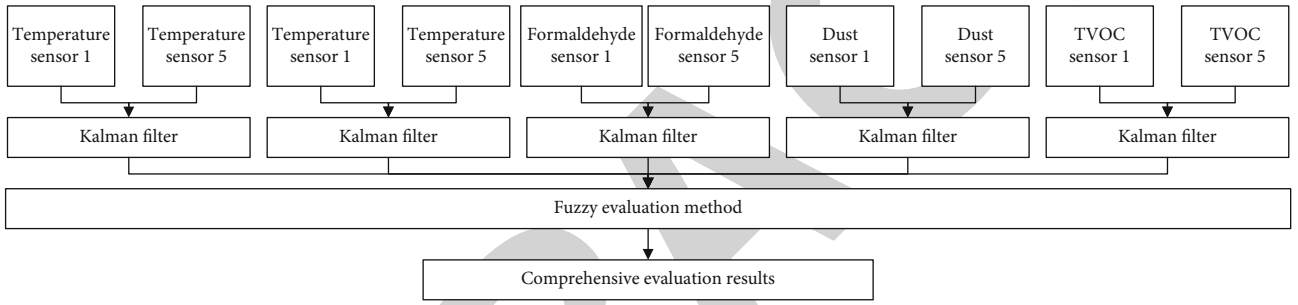

Figure 2: Two-stage parallel fusion model.

to the differences in the gas sensor itself and its environment, the noise frequency also changes, so when the frequency of some noise overlaps with the bandwidth of the desired signal, the classical filter for distinguishing the spectral response does not apply. In order to reduce the random measurement error caused by the quality of the sensor equipment and the aging of the components in the process of collecting data of the homogeneous sensor and reduce the noise pollution of the sensor caused by external factors such as temperature, humidity, air pressure, wind speed, and light changes, Mann filtering can well control the interference of noise on real data and provide statistically accurate and effective data for the second-level data fusion.

The main steps of the Kalman filter algorithm are as follows.

(1) The equation for the predicted value is as follows:

$$\mathbf{P}(k|k-1) = \mathbf{TP}(k-1|k-1) + \mathbf{BU}(k). \quad (1)$$

In the formula, $\mathbf{P}(k \mid k-1)$ is the result predicted by the previous state, $\mathbf{T}$ is the state transition matrix, $\mathbf{P}(k-1 \mid k-1)$ is the optimal result of the previous state, $\mathbf{B}$ is the input control term matrix, and $\mathbf{U}(k)$ is the current state control quantity.

(2) The covariance matrix equation for the error between the predicted value and the true value is as follows:

$$C(k|k-1) = \mathbf{TC}(k-1|k-1)T^{\mathrm{T}} + \mathbf{N}. \quad (2)$$

In the formula, $C(k \mid k-1)$ is the covariance of the prediction result of the previous state, $\mathbf{TC}(k-1 \mid k-1)$ is the covariance of the optimal result of the previous state, and $\mathbf{N}$ is the noise covariance.

(3) The Kalman gain equation is as follows:

$$G(k) = \frac{\mathbf{C}(k|k-1)\mathbf{M}^{\mathrm{T}}}{\mathbf{MC}(k|k-1)\mathbf{M}^{\mathrm{T}} + \mathbf{E}}, \quad (3)$$

where $G(k)$ is the Kalman gain, $\mathbf{M}$ is the measurement matrix, and $\mathbf{E}$ is the measurement noise covariance.

(4) The filter estimation equation is as follows:

$$\mathbf{P}(k|k) = \mathbf{P}(k|k-1) + G(k) \quad \mathbf{Z}(k) - \mathbf{MP}(k|k-1)]. \quad (4)$$

In the formula, $\mathbf{P}(k \mid k)$ is the current optimal estimated value, and $\mathbf{Z}(k)$ is the measured value of the sensor.

(5) The covariance matrix update equation is as follows:

$$\mathbf{C}(k|k) = [-\mathbf{G}(k)\mathbf{M}(k)]\mathbf{C}(k|k-1), \quad (5)$$

where $\mathbf{C}(k \mid k)$ is the covariance of the current optimal estimation result and I is the identity matrix.

According to the above equation, the core idea of summarizing the Kalman filter algorithm is to calculate the current optimal value based on the current measurement value of the sensor and the predicted value and error at the previous moment.

Due to the large number of heterogeneous sensors in this system, only 20 sets of data collected by five sets of temperature sensors are shown for first-level fusion. The temperature values collected by the temperature sensor are shown in Table 1.

By performing Kalman filtering on the collected 20 sets of data, the first-level fusion result of the temperature sensor is output. The Kalman filtering simulation result of the temperature sensor value is shown in Figure 3, and the error comparison result is shown in Figure 4.

It can be seen from the filtering results in Figure 4 that the temperature sensor value after the first stage fusion is 28.06°C, and the average value of the 20 sets of data is 28.07°C. The standard value of 28°C is used to measure the accuracy of the Kalman filter algorithm and the average algorithm, and the superiority and accuracy of the Kalman filter algorithm are compared through the final results. The error result comparison chart in Figure 5 also shows the ability of the Kalman filter algorithm to process data. The error after Kalman filter is smaller than the measured value and only 0.21%, which indicates that the Kalman filter algorithm satisfies the first requirements for data processing in the process of level fusion.

Table 1: Temperature statistics.

Sample number	Temperature	Sample number	Temperature
1	28.1	11	27.8
2	28.1	12	27.9
3	28.2	13	28.0
4	27.9	14	28.1
5	28.0	15	28.1
6	28.0	16	28.1
7	28.2	17	28.2
8	28.3	18	28.3
9	28.1	19	28.0
10	28.0	20	28.0

4. Heterogeneous Sensor Fusion Algorithms

The basic principle is to first determine the set of factors for evaluating environmental quality; then, determine the weight of each factor and its membership vector to obtain a fuzzy evaluation matrix. Finally, fuzzy operation is performed on the fuzzy evaluation matrix and factor weight vector and normalized, and the fuzzy comprehensive evaluation result is obtained. For all kinds of environmental data monitored, people are not interested in their values; what they care about is the comfort brought by the quality of the environment. Therefore, on the basis of the first-level Kalman filter, in order to effectively and reasonably evaluate a variety of environmental factors, the fuzzy comprehensive evaluation method can avoid the limitation of a single sensor to evaluate the environmental quality. The fuzzy comprehensive evaluation method transforms qualitative evaluation into quantitative evaluation through the theory of fuzzy mathematics membership degree, that is, comprehensive evaluation of things or objects affected by various factors.

4.1. Determine the Weight of Each Factor. For the environmental monitoring system indicators in this paper, the weights refer to the importance of temperature, humidity, formaldehyde content, PM2.5 content, and TVOC content for environmental quality evaluation. In the fuzzy comprehensive evaluation, the weight has a great influence on the final evaluation result. Different weights sometimes lead to completely different conclusions. Therefore, choosing an appropriate method to determine the weight of each factor is a key step in the environmental evaluation system. Generally, the Analytic Hierarchy Process (AHP) is chosen to determine the weights, but this algorithm is biased towards human subjective factors and mainly includes personal qualitative judgments, which makes the weight distribution poor. The entropy method refers to a mathematical method used to judge the degree of dispersion of a certain index. In information theory, entropy is the quantification of the degree of disorder in the system. It can measure the amount of information provided by the original data, the amount of information provided by each indicator to determine the indicator weight. The smaller the information entropy, the lower the disorder degree of the information, the greater the utility value of the information in the comprehensive evaluation, and the greater the weight of the index. That is, the entropy value method can profoundly reflect the utility value of the entropy value of the index information, overcome the subjective defects of the AHP, and improve the reliability and accuracy of the index weight. Finally, the entropy value method is used to determine the weight. According to the algorithm steps of the entropy method, a mathematical model is established through MATLAB, and the data in Table 2 is substituted into the program to obtain the relevant weights $A = \{a1, a2, a3, a4, a5\}$, where the weight values are arranged in the order of temperature, humidity, formaldehyde, PM2.5, and TVOC. The specific algorithm process is as follows.

(1) First, the data in Table 2 is represented in the form of a matrix

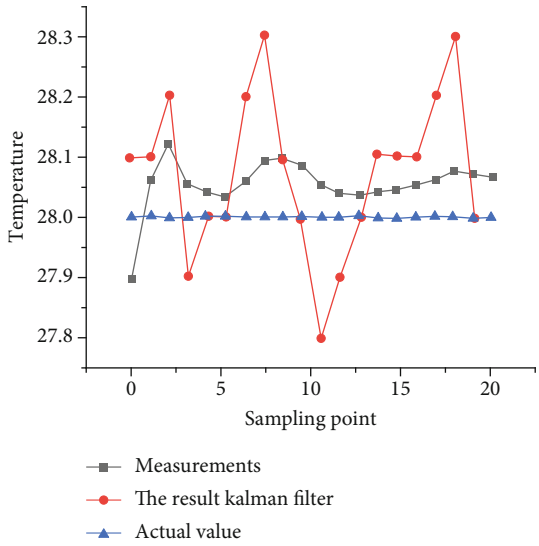

Figure 3: Kalman filter of temperature sensor.

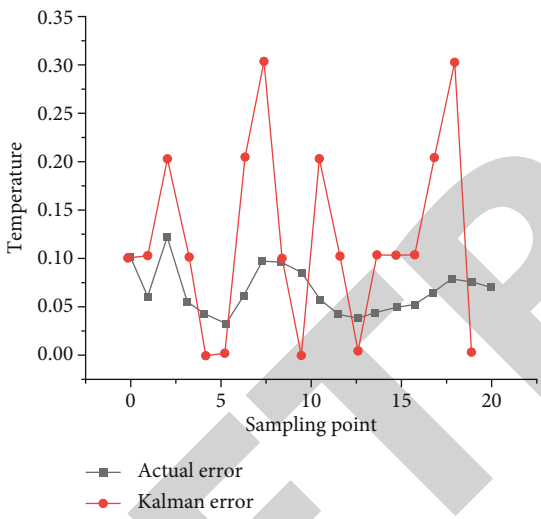

Figure 4: Error comparison.

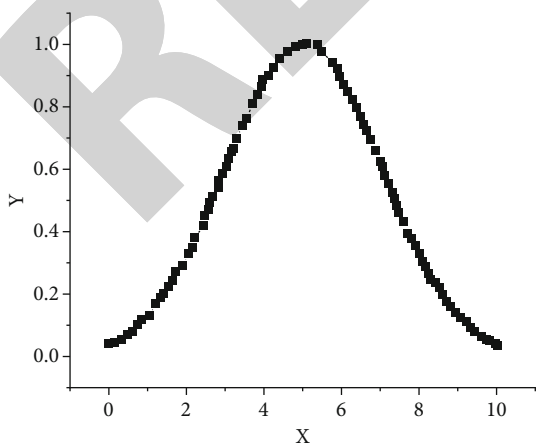

Figure 5: Gaussian membership function.

(2) The data are normalized according to the formula

$$x'_{ij} = \frac{x_{ij} - \min\{x_{ij},\cdots,x_{nj}\}}{\max\{x_{1j},\cdots,x_{nj}\} - \min\{x_{1j},\cdots,x_{nj}\}} n = 1 \cdots 5. \quad (6)$$

(3) Calculate the proportion of normalized data

$$p_{ij} = \frac{x_{ij}}{\sum_{i=1}^{n} x'_{ij}}, \quad i = 1, \cdots, n,\ j = 1, \cdots, m. \quad (7)$$

(4) Calculate the entropy value for each factor

$$e_j = -k \sum_{i=1}^{n} p_{ij} \ln\left(p_{ij}\right) k = \frac{1}{\ln 5}. \quad (8)$$

(5) Calculate the information entropy redundancy for each factor

$$d_j = 1 - e_j. \quad (9)$$

(6) Calculate the weight of each factor

$$w_j = \frac{d_j}{\sum_{j=1}^{m} d_j} m = 1, \cdots, 5. \quad (10)$$

4.2. Determining Fuzzy Relationship Matrix. The key to determine the fuzzy relationship matrix R is to determine the membership function and calculate the membership degree of each element in the comment set through the membership function. According to the environmental indicators in this paper, the Gaussian membership function is selected for solving, because each sensor value conforms to the normal distribution under each evaluation set. Its expression is as follows:

$$y = e^{-[x-b)/\sigma]^2} - \infty < x < +\infty. \quad (11)$$

In the formula, x is the value of each sensor after the first-level fusion, b is the standard value of the evaluation set V corresponding to each sensor, and σ is the standard deviation of the evaluation set corresponding to each sensor.

The simulation of the Gaussian membership function model is shown in Figure 5, where the standard deviation $\sigma = 2$ and $b = 5$.

Table 2: Environmental monitoring values.

Surroundings	Temperature (°C)	Humidity (%RH)	Formaldehyde (mg/m^3)	PM2.5 (μg/m^3)	TVOC (mg/m^3)
1	28.1	58.5	0.021 2	70.2	0.02
2	28.1	58.6	0.022 5	70.0	0.03
3	28.2	58.2	0.021 2	69.8	0.03
4	27.9	58.5	0.023 7	70.0	0.02
5	28.0	58.3	0.021 2	70.2	0.02
6	28.0	58.4	0.021 2	70.2	0.02
7	28.2	58.6	0.022 5	70.1	0.03
8	28.3	58.3	0.021 2	70.0	0.03
9	28.1	58.6	0.023 7	70.3	0.03
10	28.0	58.5	0.022 5	70.1	0.03
11	27.8	58.5	0.020 0	69.9	0.04
12	27.9	58.4	0.022 5	69.9	0.03
13	28.0	58.5	0.022 5	70.0	0.02
14	28.1	58.6	0.021 2	70.0	0.02
15	28.1	58.5	0.021 2	70.1	0.02
16	28.1	58.5	0.023 7	70.0	0.03
17	28.2	58.3	0.022 5	70.1	0.03
18	28.3	58.4	0.022 5	69.9	0.03
19	28.0	58.5	0.021 2	70.0	0.03
20	28.0	58.5	0.021 2	70.0	0.03

5. Analysis and Verification of Data Fusion Algorithms

The collection site was selected on the first floor of the Fok Ying Tung Building of Zhongkai University of Agriculture and Engineering. The five environmental monitoring systems were placed separately, and the data was collected every 15 minutes, 4 times for a total of 20 groups, and the data is drawn in Table 3.

According to the steps of the above multisensor fusion algorithm, the data of each homogeneous sensor is first fused, and the result after Kalman filtering is {temperature: 28.06°C, humidity: 58.45%RH, formaldehyde: 0.021 mg/m^3, PM2.5: 70.02 μg/m^3, TVOC: 0.025 mg/m^3}.

The second-level fusion determines the factor set $U = \{$ temperature, humidity, formaldehyde, PM2.5, TVOC$\}$ and the comment set $V = \{$good, better, fair, poor, poor$\}$ according to the fuzzy comprehensive evaluation algorithm steps. Then, determine the weight of each factor, and calculate $A = \{0.1117, 0.1021, 0.1239, 0.1211, 0.5412\}$. Then, the fuzzy relation matrix is determined according to the Gaussian membership function of each sensor.

In order to better verify the rationality and effectiveness of the system fusion algorithm, the environmental conditions of the road near Zhongkai University of Agriculture and Engineering and the construction unit of a real estate building were tested respectively. First test the environmental conditions of road crossings near Zhongkai University of Agriculture and Engineering. Kalman filter result {temperature: 19.83°C, humidity: 52.795%RH, formaldehyde: 0.048 0 mg/m^3, PM2.5: 92.82 μg/m^3, TVOC: 0.047 mg/m^3}. Due to the seasonal changes of the collected data, the standard values of the temperature index evaluation set are adjusted accordingly. Calculate the standard deviation of the standard value of the temperature index evaluation set $\sigma = 5.38$. According to formula (11), the Gaussian membership function of the temperature index is obtained:

$$r_{ij} = e^{-\left[19.83-b_{ij}\right)/5.38]^2}, \quad -\infty < x < +\infty. \tag{12}$$

Using the collected monitoring data, the fusion algorithm is used to measure the weight vector A of each environmental factor of the road near Zhongkai University of Agriculture and Engineering, and the fuzzy relation matrix R is as follows.

$$R = \begin{bmatrix} 0.1533 & 0.3281 & 0.3856 & 0.1193 & 0.0137 \\ 0.2343 & 0.4097 & 0.2559 & 0.0970 & 0.0031 \\ 0.2621 & 0.4422 & 0.2201 & 0.0649 & 0.0107 \\ 0.1824 & 0.3197 & 0.3095 & 0.1849 & 0.0035 \\ 0.7673 & 0.2111 & 0.0209 & 0.0007 & 0.0000 \end{bmatrix}. \tag{13}$$

According to formula (12), the fuzzy comprehensive evaluation result vector $C = \{0.3067, 0.3464, 0.2483, 0.0914, 0.0071\}$ is calculated. "Good" accounted for a relatively high proportion. Using the principle of maximum membership, the environmental quality of roads in this area is better. Compared to the environmental conditions in the area, the environmental quality of roads has declined. In order to

Table 3: Road monitoring data near Zhongkai University of Agriculture and Engineering.

Surroundings	Temperature (°C)	Humidity (%RH)	Formaldehyde (mg/m^3)	PM2.5 (μg/m^3)	TVOC (mg/m^3)
1	19.7	52.6	0.021 2	70.2	0.04
2	28.1	52.6	0.022 5	70.0	0.04
3	28.2	52.8	0.021 2	69.8	0.05
4	27.9	58.5	0.023 7	70.0	0.03
5	28.0	52.8	0.021 2	70.2	0.02
6	28.0	58.4	0.021 2	70.2	0.02
7	28.2	52.6	0.022 5	70.1	0.03
8	28.3	58.3	0.021 2	70.0	0.03
9	28.1	52.6	0.023 7	70.3	0.03
10	19.7	58.5	0.022 5	70.1	0.03
11	27.8	58.5	0.020 0	69.9	0.04
12	20.0	52.6	0.022 5	69.9	0.03
13	28.0	52.6	0.022 5	70.0	0.02
14	20.1	58.6	0.021 2	70.0	0.02
15	28.1	58.5	0.021 2	70.1	0.02
16	20.1	52.6	0.023 7	70.0	0.03
17	19.9	58.3	0.022 5	70.1	0.03
18	28.3	52.6	0.022 5	69.9	0.03
19	19.8	58.5	0.021 2	70.0	0.03
20	19.8	58.5	0.021 2	70.0	0.03

reflect the rationality and effectiveness of the algorithm in this paper, the monitoring data obtained from the provincial air quality real-time release system network are compared as shown in Figures 6–8, where Figure 6 represents the change of PM2.5 in 24 hours, Figure 7 represents the change in AQI within 24 hours, and Figure 8 represents the change in AQI within a week.

It can be seen from Figures 6–8 that the environmental indicators monitored by the provincial environmental monitoring center station are SO2, NO2, CO, O3, PM10, and PM2.5. It uses AQI (Air Quality Index) to determine the environmental quality, which is divided into six levels. In this monitoring period, the environmental quality of the area is shown to be second-level good, and the environmental quality measured by the data fusion algorithm in this paper is good, which can well reflect the rationality and effectiveness of the system algorithm in this paper. In order to further improve the rationality and effectiveness of the fusion algorithm, a construction unit of a building near the area was tested, where Kalman filter result {temperature: 21.83°C, humidity: 58.922% RH, formaldehyde: 0.0618 mg/m^3, PM2.5: 180.95 μg/m^3, TVOC: 0.0795 mg/m^3}. According to the data fusion algorithm in this paper, the weight vector $A = \{0.3799, 0.0689, 0.1889, 0.1523, 0.2100\}$ and the fuzzy relation matrix R as follows. According to formula (12), the fuzzy comprehensive evaluation result vector $C = \{0.2934, 0.2981, 0.2287, 0.1352, 0.0446\}$ is calculated; using the principle of maximum membership degree, it can be seen that the region environmental quality is better. Through the analysis and verification of the above three sets of experimental data, the reliability of the environmental quality detection results obtained by applying the multisensor fusion model in this paper is relatively high.

6. Conclusions

In this paper, the environmental monitoring system designed by NB-IoT technology and multisensor technology is used to collect data such as temperature, humidity, formaldehyde concentration, PM2.5 concentration, and TVOC concentration through the STM32F103C8T6 microcontroller. Firstly, median filtering is performed on the data collected by various sensors before the first-level data fusion, in order to eliminate abnormal data caused by external factors and provide accurate data for Kalman filtering. Kalman filtering is performed on the data of homogeneous sensors to realize the first-level data fusion, and the purpose is to provide effective data in statistical significance for the second-level fusion. Among them, the error brought by the Kalman filter is relatively small. Then, the fuzzy comprehensive evaluation method is used to fuse the data of heterogeneous sensors at the second level. The weight of each index is determined by the entropy method, which can solve the error caused by human factors, and the membership degree is solved by the Gaussian membership function. The characteristics of the normal distribution of the values are finally obtained, and the comprehensive evaluation results of the environmental quality are finally obtained. The research results of this paper will provide a useful reference for environmental monitoring-related technologies. Intelligence is the trend and trend of industrial development in modern society. Many fields and disciplines involved in multisensor

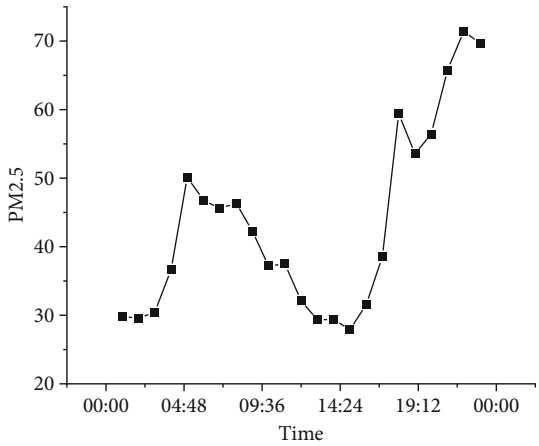

Figure 6: PM2.5 change in 24 hours.

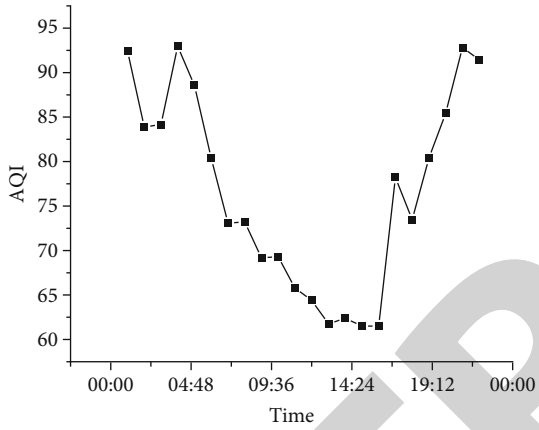

Figure 7: Changes in AQI within 24 hours.

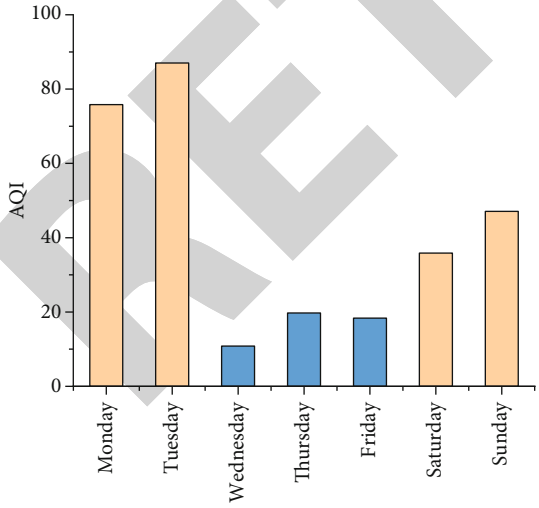

Figure 8: Changes in AQI within a week.

data fusion technology are closely related to artificial intelligence. In the future, multisensor data fusion technology will also develop towards intelligence.

Multisensor fusion technology is a multidisciplinary advanced technology, and its development direction needs to meet the needs of current industrial development and social development, to meet people's daily work, life, production needs. Whether it is used in military, civilian, or scientific research, it can exert practical advantages. Multisensor data fusion technology needs to make it possible to achieve high-speed online fusion on the premise of ensuring robustness and accuracy. In the future, multisensor data fusion technology will still require hardware technology. With the support of continuous optimization algorithm calculation speed, improve the ability of high-speed online fusion.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Acknowledgments

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Retraction

Retracted: Personalized Recommendation Evaluation of Credit Degree Based on New Hybrid Crow Search Algorithm for E-Commerce Live Industry Data Analysis

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] Y. Ma, "Personalized Recommendation Evaluation of Credit Degree Based on New Hybrid Crow Search Algorithm for E-Commerce Live Industry Data Analysis," *Journal of Sensors*, vol. 2022, Article ID 6023031, 11 pages, 2022.

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Research Article

Personalized Recommendation Evaluation of Credit Degree Based on New Hybrid Crow Search Algorithm for E-Commerce Live Industry Data Analysis

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With the advent of the era of national live broadcast, the "live broadcast + e-commerce" model reconstructs "people, goods, and fields", and merchants, platforms, and anchors create a new marketing system around consumers' perceptions, attitudes, and emotions to enhance consumer willingness. E-commerce live broadcast ultimately brings back the core of marketing, according to retailers. The psychological contract in the live broadcast is a variable, and its commitment or breach will have an effect on the consumer attitude and consumer emotions. From the perspective of the consumer, stronger consumption motivation, content quality, Netflix charm, trust, and highly interactive consumer expectations must exist. Based on the above background, the understanding of business infrastructure in the digital economy era should also be dynamically adjusted in conjunction with the concept of new infrastructure and business innovation practices. This paper investigates personalized recommendation assessment of credit degree based on data analysis of the live e-commerce industry based on new hybrid crow search algorithm in this context, delves into the state of e-commerce in China today, offers a profound discussion on e-commerce as well as credit degree, and concludes the paper with a general summary.

1. Introduction

With the arrival of the era of national live broadcast, the "live broadcast + e-commerce" model reconstructs "people, goods, and fields", and merchants, platforms, and anchors create a new marketing system around consumers' perceptions, attitudes, and emotions to enhance consumption willingness. From the perspective of merchants, e-commerce live broadcast ultimately to return to the essence of marketing. From the consumer's point of view, driving consumer behavior to live consumption is bound to have a stronger consumer motivation, content quality, Netflix charm, trust, and a high degree of interaction reflected in the consumer expectations and constitute the psychological contract in the live broadcast; as a variable, its commitment or breach will have an impact on the consumer attitude and consumer emotions. From the psychological contract, "live streaming + e-commerce" is not only a technical paradigm but also a personalized and emotional marketing model [1].

According to actual trends, the development of new commercial infrastructure has received significant attention in recent years from the federal government, the provinces, the cities, and the businesses themselves [2]. At the national level, the State Council of the CPC Central Committee has implemented a new "double cycle" development strategy, as well as policies and measures on reforming the consumption and circulation system and building new infrastructure that take into account the needs for building new business infrastructure. At the provincial and municipal levels, many provinces and cities have laid out new business infrastructures from different perspectives, focusing on the cultivation of economic dynamics [3]. At the enterprise level, from Alibaba relying on the advantages of e-commerce development of the "box horse fresh-sang" new retail to Tencent relying on social traffic extension of business services, and Meituan relying on super platform links to local life, and then to Jindong Logistics and Shunfeng Group focus on building an integrated supply chain logistics service system, and then

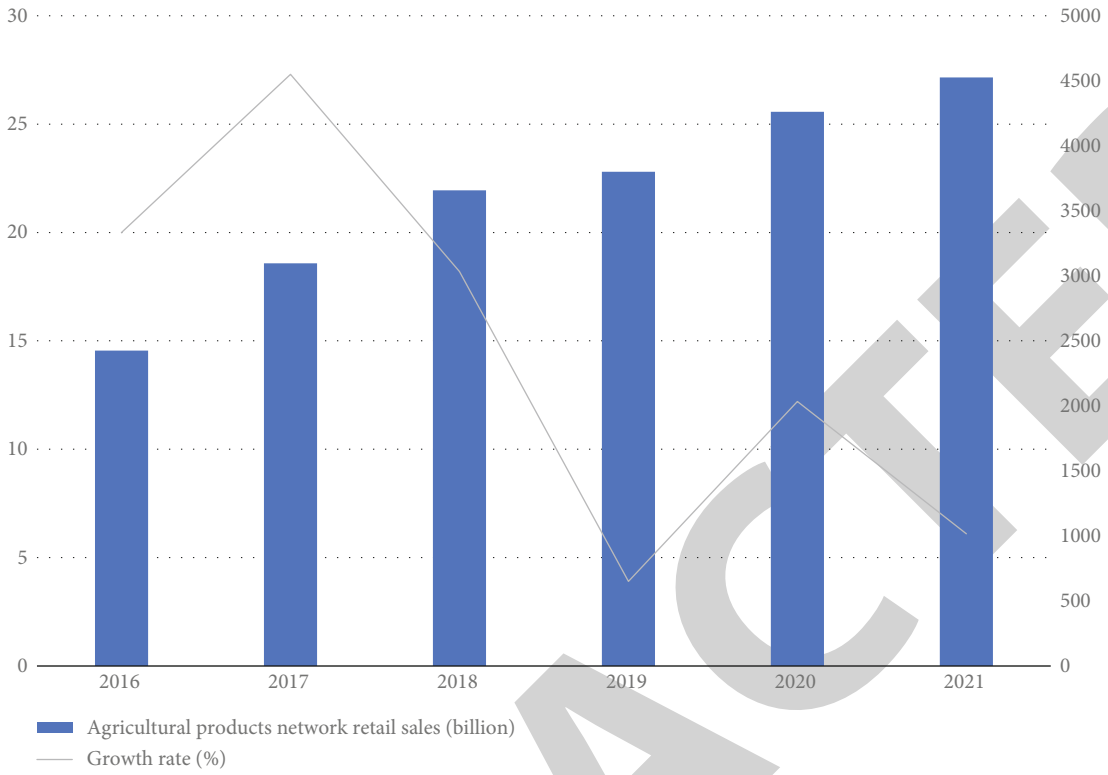

Figure 1: Statistics on the scale of agricultural products e-commerce transactions in China from 2016-2021.

to live broadcast platform such as Juchang, Racer evolved into live e-commerce. Meanwhile, the development of live e-commerce and community group purchase in the prevention and control of the new crown epidemic in 2020 has demonstrated the important role of digitization-centered new business infrastructure construction, and the pressure to maintain supply brought by the multipoint epidemic distribution in 2022 has further highlighted its critical role [4].

Due to the scale of agricultural e-commerce transactions, as depicted in Figure 1, this paper investigates the personalized recommendation assessment of credit degree based on the new hybrid crow search algorithm [5].

2. Research Background

The digital economy has impacted every aspect of the Chinese economy and people's lives, and new technologies, business models, and modes of communication are thriving thanks to the growth of e-commerce platforms [6]. With its attribute that "everything can be broadcast, everyone can be broadcast, and everywhere can be broadcast," live e-commerce has quickly emerged as a new hot spot in e-commerce and consumption [7]. Live e-commerce is rapidly changing people's shopping and consumption habits, becoming a new marketing model for e-commerce sales, making live broadcast a new windfall and development mode for e-commerce, and becoming the focus of competition in various industries [8]. Live e-branding, commerce's clustering, and specialization traits have been discussed. A new opportunity for the entity industry has emerged as the study claims that the total scale of China's live e-commerce industry reached 433.8 billion RMB in 2019, and that the number of online live users in China reached 526 million in 2020. The study also claims that the industry's scale has approached a trillion dollars in volume and will reach two trillion dollars by 2021. The live streaming fever in China has not only made the use of live streaming to make product sales more widespread in its own country, but the fever has also spread around the world, throughout Europe, America, and Southeast Asia [9]. The soaring e-commerce live streaming craze in China has inspired e-commerce companies in Southeast Asia and some European and American countries. The outbreak of the epidemic in 2020 made traditional cross-border companies face pressure from logistics, supply chain, capital and other aspects, traditional offline foreign trade channels were frustrated, and the popular live streaming with goods in China began to go abroad, which led to the initial development of cross-border live streaming, a surge in traffic data of major cross-border e-commerce platforms, and a qualitative change in the shopping habits of overseas consumers [10]. The success of the 2020 China Canton Fair has further promoted the forward development of cross-border live streaming, and more international cross-border e-commerce platforms have aimed at the windfall and joined the live streaming army [11]. By March 2021, the growth rate of online sales in the United States is 48%, in which a large increase is live streaming with goods. Since all market behaviors have cultural boundaries and the political and cultural characteristics of a nation or country at a given time largely determine the consumer behavior and

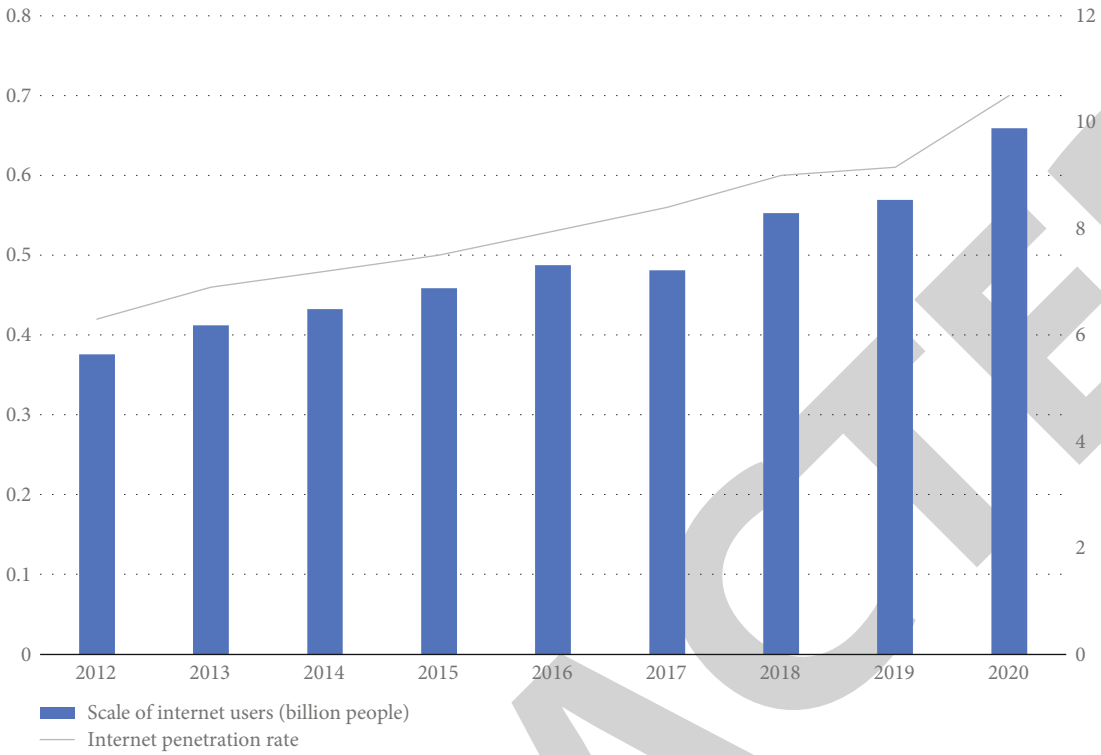

Figure 2: Scale of Internet users and Internet penetration rate in China from 2012 to 2020.

business model of that nation or country at that particular time, the development of cross-border e-commerce must always contend with this cross-cultural marketing dilemma [12]. Therefore, increasing cultural sensitivity and awareness is crucial for the growth of international e-commerce. The size of Chinese Internet users and Internet penetration rate from 2012 to 2020 is shown in Figure 2.

This study aims to analyze the effects of cross-border live streaming on the effectiveness of market promotion from a cross-cultural perspective when targeting different countries and regions because, when combined with the local native culture, consumer behavior is influenced by culture [13]. This study also aims to identify the changes and impacts caused by the application of live e-commerce to the general economic environment of cross-border e-commerce platforms. In order to practice a live broadcast mode that can increase the marketing effectiveness of each country under the influence of localization factors, use new media marketing to promote the development of cross-border e-commerce, promote the quality and upgrade of digital consumption, and build a sustainable business; it is necessary to identify the characteristics and features of the cross-border cross-cultural characteristics of the live broadcast operation mode of multinational e-commerce platforms.

In the context of the global has stepped into the era of digital economy, digital economy as a new form of economy with rapid development, extensive radiation, and active innovation [14]. The impact of the new crown pneumonia epidemic has made the advantages of digital trade gradually emerge. The digital economy, as the future development pattern of the world economy, has reshaped the development direction of the world economy, impacted the direction of the international economic and political system, and set off changes in finance, trade, technology, security, and other aspects [15]. While cross-border e-commerce as a cross-border and cross-cultural business activity, the impact of cultural distance on business activities is still inevitable, and although the application of Internet and digital technology has diluted the differences in space and time, cultural differences are still the main factors affecting cross-border business. Cultural factors play a key role in consumer behavior and psychology to the extent that they influence consumption outcomes and consumer trends [16]. Therefore, actively integrating and correctly understanding different local cultures around the world and actively exploring cross-cultural operation strategies and approaches that are in line with efficient cross-border e-commerce platforms are also inevitable paths for the sustainable development of cross-border e-commerce.

3. Materials and Methods

3.1. Basic Theory

3.1.1. Live E-Commerce. Due to the Internet's widespread use, the world's trade and economy are now closely intertwined. Additionally, as e-commerce has grown quickly, so have the number of e-commerce businesses, leading to the vigorous development of the e-commerce platform. E-commerce platforms offer greater ease of communication

between businesses across borders when compared to traditional trade methods, to the point where they better encourage the formation of transactions between buyers and sellers and significantly increase the trade volume of foreign trade enterprises [17]. A foreign scholar elaborated that e-commerce platforms provide a sales platform for different enterprises to enter the global market, and the relationship between both e-commerce platforms and enterprises that sell online through e-commerce platforms brings many challenges to enterprises. Market operation is a crucial component of business development and is also crucial for the growth of cross-border e-commerce, according to a Shaanxi scholar. Only by maximizing the role and value of market operation can the long-term and smooth development of e-commerce enterprises be ensured [18]. According to a research team from Peking University, cross-border e-commerce has a business model that is constantly evolving and new compared to traditional domestic e-commerce. The market structure and business model of domestic e-commerce platforms are comparatively stable, but the competitive and quickly evolving international market will cause some of the businesses that were moving abroad to be eliminated by the market while also sparking the emergence and development of new business models. Small and medium-sized foreign trade enterprises are currently experiencing some phenomena and problems with the development of cross-border e-commerce. According to some scholars in Hongshan, these issues include uneven product quality, poor cross-border logistics, and insufficient operational capacity, all of which have an impact on the future growth of cross-border e-commerce [19]. Also present on the e-commerce platform are the live banding trend, commodity centralization, and diversification of model subjects. Cross-border e-merchants should improve the security and convenience of the platform by optimizing the platform design and continuously improve the quality of the products in order to significantly improve the platform's overall competitiveness; according to some studies that have found that the quality of the products and the security and convenience of the platform are the key factors affecting the operation of cross-border e-commerce platforms at present. The use of new media for content promotion and dissemination can more effectively increase the visibility of e-commerce platforms, so a study exploring the background of the new media marketing model that is gradually replacing the traditional network marketing model has found that new media marketing has become an unavoidable trend of the future development of e-commerce platform operation. For the future development of the e-commerce platform, the organic fusion of new media marketing and platform operation will present countless opportunities and challenges.

The widespread use of live streaming for goods by e-commerce platforms assisted by mobile communication technology and Internet applications has resulted in the creation of a brand-new economic structure known as the "live economy." According to some researchers, using e-commerce platforms for live streaming merchandise has greatly benefited both platforms and merchants, and platform transactions have been rising, making the live streaming economy a common sales model at the moment. According to other researchers, live webcasting of products is a growing business model that employs live streaming technology to show products online in real time, assist customers in making purchases, and respond to customer inquiries locally [20]. The explosive growth of live streaming with goods has given economic development new impetus and continues to do so based on its features of good value and high interactivity. This is due to the rapid popularity of mobile Internet. According to some studies, e-commerce live marketing will become more professional and standardized in the future with the innovative development of AR and VR technology and the further popularization of 5G technology. It will also become more intelligent and accurate, with a more adaptable personality. Italian academics noted that live streaming recently has not only offered a new marketing strategy for corporate brands but has also offered a new direct marketing channel for some small individual households. Live streaming has also improved consumer engagement by enhancing interactions between businesses and their patrons. Indian scholars examine the success factors, benefits, and drawbacks of live e-commerce based on the state of its development in China. They then project how live e-commerce will develop in the future, stating that it will eventually become the "standard configuration" of e-commerce, branding, and business. The research group at Lanzhou University emphasizes that the innovative development of marketing mode will be aided by the media's renewal. According to some academics, live broadcast is gradually incorporated into foreign trade activities under the umbrella of "Internet+," and foreign trade enterprises are starting to shrewdly use the live broadcast platform to support the growth of new digital foreign trade.

3.1.2. Data Collection and Analysis. This essay's research focus is on the big data media management model's impact on the network literacy education system for college students. Therefore, it is necessary to use the big data collection and management system. Today's big data management systems cannot only store a lot of data and create a network system that can hold a lot of data, but they can also analyze and process the data very quickly. A big data management system makes reasonable use of media like computers and networks to analyze and process a variety of data. It is becoming faster and more convenient to transmit and process digital information, and it is gradually being applied to more and more areas of life. This has a significant positive impact on people's ability to learn in the future, updates people's traditional views of data management, and significantly increases their ability to work efficiently. As shown in Figure 3, there are four main characteristics of big data management systems: a large storage volume, quick information processing, accurate and useful data results, and a wide range of data types.

3.2. Research Methods

3.2.1. New Hybrid Crow Search Algorithm

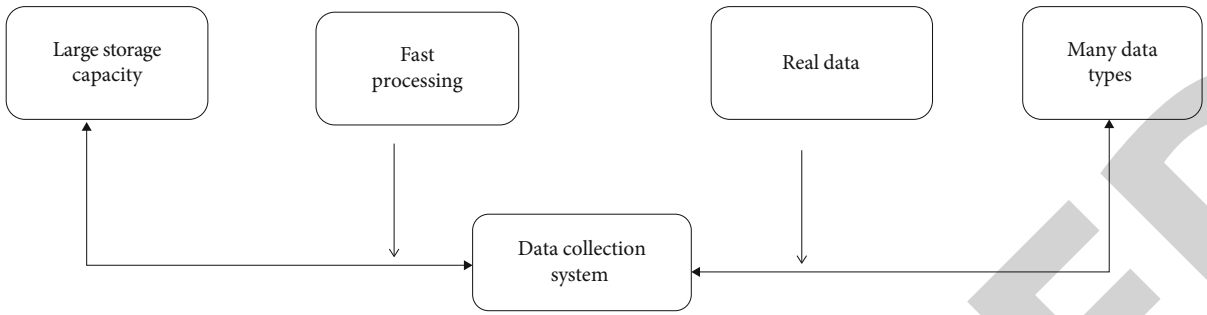

Figure 3: Characteristics of data collection system.

(1) Basic Crow Search Algorithm (CSA)

The crow search algorithm is a novel form of swarm intelligence that is based on the social behaviors of crows in nature, such as following one another to steal food and having good memory and communication skills. The algorithm is based on four basic rules: (1) crows live in groups; (2) crows can remember the location of food storage; (3) crows follow each other to steal food; and (4) crows can protect food from theft with a certain probability

Assume that the maximum number of algorithm iterations is G, the crow population is N, and the crows are active in D-dimensional space. The CSA algorithm works as follows: step 1: randomly sets up each crow's position; step 2: sets up the locations of each crow that is storing food; step 3: in order to determine the next object and update its location, each crow makes a random selection; step 4: determines each crow's fitness value; step 5: updates the locations of every crow that is feeding; step 6: if the algorithm's termination condition is met, the algorithm ends if ste6 produces the best solution to the problem (i.e., the location where all crows should store their food), failing which step 3 is invoked.

(2) New Hybrid Crow Search Algorithm (NHCSA) for solving PFSP

The encoding method is transformed with SPV. The iterative greedy algorithm deals with discrete artifact ordering directly, while the basic crow search algorithm is only suitable for optimizing continuous problems and cannot solve the PFSP directly. This paper converts between a set of continuous values representing the position and the artifact ordering based on SPV rules. The conversion of position to workpiece ordering is performed by selecting the dimension to which the smallest value belongs from a set of position values as the next workpiece to be processed each time, until all position values are traversed. The spatial dimension D takes the value of the number of artifacts n.

Initialization of the population, the effectiveness, and performance of the algorithm iterations are enhanced by a strong initial population. The NEH heuristic algorithm is the most popular approach because it can produce high-quality results quickly and when combined with population initialization, it can guarantee that the initial population contains individuals of high caliber.

In view of the simplicity and effectiveness of NEH, some scholars have conducted in-depth researches on it and proposed various NEH-based improvement algorithms, such as NEHD, NEHLJP1, NEHFF, NEHKK1, CLWTS, etc. Among them, NEHLJP1 is the one with the strongest merit-seeking ability. NEHLJP1 obtains the priority sequence of workpieces based on the mean, standard deviation, and skewness of the completion time of each workpiece on all machines; the TBLJP1 merit-seeking mechanism is proposed, which determines the final insertion position based on the sum of the weighted sum of the completion times of the workpieces to be inserted on different machines and the minimum amount of gap change generated during the insertion process. However, like other NEH-based heuristic algorithms, NEHLJP1 often generates multiple artifacts with minimum completion times and different sequences in the scheduling process of the last artifact, but only one of them can be selected as the result of the algorithm operation in the end, thus missing the information of high-quality solutions.

Based on iterative, greedy local search, the basic crow search algorithm shares the drawbacks of easily falling into local optimum and early convergence when tackling complex problems with other swarm intelligence optimization algorithms. The use of local search techniques can, to some extent, prevent the algorithm from entering a local optimum, enhancing the accuracy of the algorithm convergence. Using the iterated greedy (IG) algorithm for local searches is straightforward and efficient. Italian researchers and others used the iterated greedy algorithm to solve the PFSP problem first, then proposed the IG RSLS algorithm and confirmed its efficacy. The NHCSA algorithm flow is depicted in Figure 4.

NHCSA is based on the crow search algorithm, which explores the solution space based on the behavior of crows following each other, decides the concentration or dispersion of crows through the cognitive probability AP, and influences the range of crow search through the flight distance; transforms between crow location and artifact ranking based on the SPV rule; uses a new initialization method for population initialization to improve the quality and diversity of the initial population, and the introduction of the TBLJP1 mechanism enables the algorithm to further select the

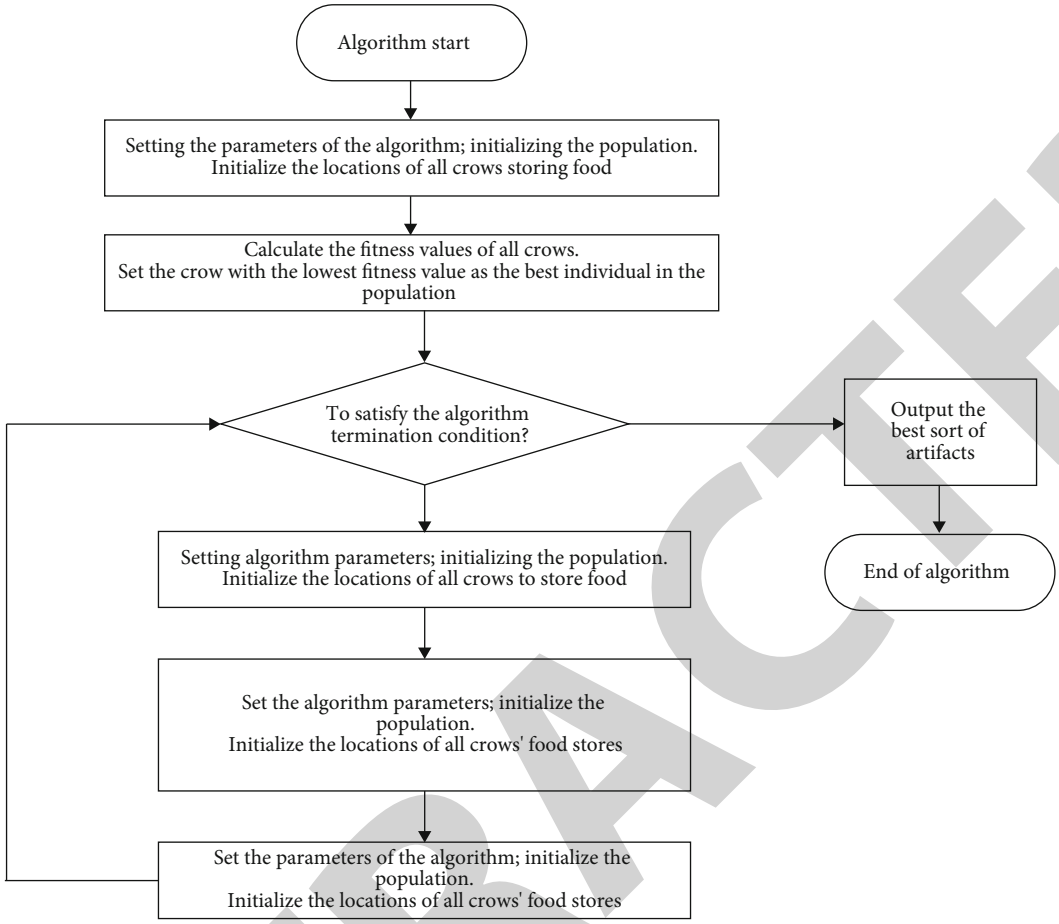

Figure 4: NHCSA algorithm flow chart.

potential optimal solution among multiple subsequences with the shortest completion time, which combines with the fast and efficient characteristics of the greedy iteration algorithm. This enhances the algorithm's ability to jump out of the local optimum, which can significantly speed up and improve the accuracy of the algorithm convergence. It also combines with the greedy iterative algorithm's fast and efficient characteristics.

The analysis of the computational complexity, since evaluating individual merit serves as a crucial foundation for the algorithm's operation, is necessary to continuously calculate each person's fitness value. A significant computational overhead is the time required to compute fitness values. The computation of fitness values is mainly concentrated in the iterative process of the algorithm, and the computation overhead of the population initialization phase is negligible.

Set (Ω, ζ, P) is a conceptual space, x the set of all wandering variables on the space involved. The risk metric ρ is a mapping x from a x_ρ subset of R to the real numbers, denoted as $\rho : X \in x_\rho \leftrightarrow \rho(X) \in R$.

First, define the g function called distortion function, if $g : [0, 1] \longrightarrow [0, 1]$, it is a monotone nondecreasing function and satisfies $g(0) = 0, g(1) = 1$.

Next, define the $\rho_g : x \longrightarrow R$ risk measure, often called distortion risk measure if $\rho_g(X)$ it satisfies:

$$\rho_g(X) \coloneqq \int_{-\infty}^{0} \lg\left(S_X(x)\right) - 1)dx + \int_0^{\infty} \mathrm{g}(S_X(x)))dx, X \in x. \tag{1}$$

Here is g the distortion function, which $S_X(x) = P(X \succ x)$ is X the tail distribution.

The X assumption is that the total risk faced $f : [0,\infty) \longrightarrow [0,\infty)$ by the insurer $f(X)$ is the partition function, representing the insurer transferring part of the risk faced by itself to the reinsurer. The reinsurer charges the insurer for the insurance premium to supplement the risk they bear because they assume a portion of the insurer's risk. In this paper, we assume that the reinsurance cost criterion has the following form.

$$\mu_r(f(X)) = \int_0^{\infty} r\left(S_{f(x)}(x)\right)dx, \tag{2}$$

where $S_{f(x)}$ is $f(X)$ the tail distribution $r : [0,\infty) \longrightarrow [0,\infty)$ about and is a monotonic nondecreasing $r(0) = 0$ function with. Without loss of generality, we assume that r it is not

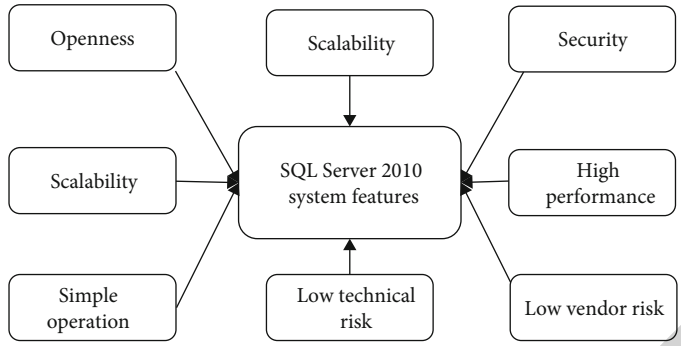

Figure 5: Main features of SQLServer2010 system.

a function that is zero almost everywhere, and that the total risk that an insurer has to face is the residual risk that it will face itself plus the cost required to transfer the risk. Expressed in the formula it can be expressed as

$$T_f(X) = X - f(X) + \mu_r(f(X)). \quad (3)$$

3.2.2. SQLServer Big Data Management System. As a new generation of database and analysis processing platform software, SQLServer database is quickly gaining popularity and acceptance from a wide range of enterprise customers. It is based on today's widely used Windows and other operating system platforms. In contrast to smaller databases like CCESS database and other popular database platforms like FoxPro, SQLServer offers a comprehensive set of robust and user-friendly database management and service processing features. There are engines that support extended feature functionality, standard SQL, and other database languages (such as replication, OLP, analysis, etc.). Additionally, it significantly outperforms the competition in terms of other crucial features, such as stored procedures and triggers, that can only be found in large database software.

Based on Microsoft SQLServer 7.0, Microsoft SQLServer2010 has been significantly expanded to improve database performance, reliability, quality management, and usability. A high-performance enterprise relational database management system with high reliability and usability is Microsoft SQLServer2010 database edition. Figure 5 illustrates the comprehensive and particular features of SQLServer2010.

Therefore, this paper selects SQLServer2010 for big data analysis; the first is SQLServer2010 version has been relatively mature; second, SQLServer is used to manage large databases, that is, analyze the use of big data; the use of this software is more appropriate; finally, SQLServer is a more commonly used software for analyzing big data, which makes it easier for other researchers to understand this paper.

3.2.3. Orcle Big Data Analysis and Research. Orcle database management system is a relational database management system from Germany Orcle software company (Chinese name Orcle) developed by the company. It is probably another database product that Microsoft will design with distributed database as its core feature. It will also be one of Microsoft's most popular distributed C/S server architecture or distributed B/S database architecture in the world. State "questioning" is one of the most attractive performance advantages of the Orcle database parallel server model compared to SQLServer. It allows you to split any subquery into any number of subqueries and then execute the subroutines on two different server CPUs. It greatly improves the performance of multiprocessing systems, which should be a potential competitive advantage in the next few years of rapid growth of the data trend. The Orcle database has a number of other significant advantages over the Orcle database and completes data storage management storage capability. The data storage capacity is large; the persistence time is long, and the data can be shared, ensuring reliability, complete related products, perfect distributed management function, simple operation, and so on. This is shown in Figure 6.

4. Results and Discussion

4.1. Economic Status Quo of E-Commerce Live Broadcast. Live streaming economy is a brand-new economic form created by the extensive use of live streaming by e-commerce platforms. It is supported by mobile communication technology and Internet application. According to some academics, the use of e-commerce platforms for live streaming has generated enormous profits for merchants and platforms, and the volume of platform transactions has been steadily increasing, making live streaming economy a common sales model at the moment. According to some academics, webcast is a new business model that employs live broadcast technology to show products online in real time, direct customers to make purchases, and respond to customer questions locally. The explosive growth of live streaming, which has been fueled by the rapid uptake of mobile Internet, has given economic growth a new lease on life and continues to do so by leveraging its advantages of high-quality, low cost, and robust interaction. According to some studies, e-commerce live marketing will become more professional, standardized, intelligent, accurate, and flexible in the future with the innovative development of AR and VR technology and the further popularization of 5G technology. Italian scholars mentioned that recently, live streaming not only provides a new marketing method for corporate brands but also provides a new direct marketing channel for some small self-employed. Live streaming enhances the interaction between merchants and consumers and greatly increases the participation of consumers. Based on the

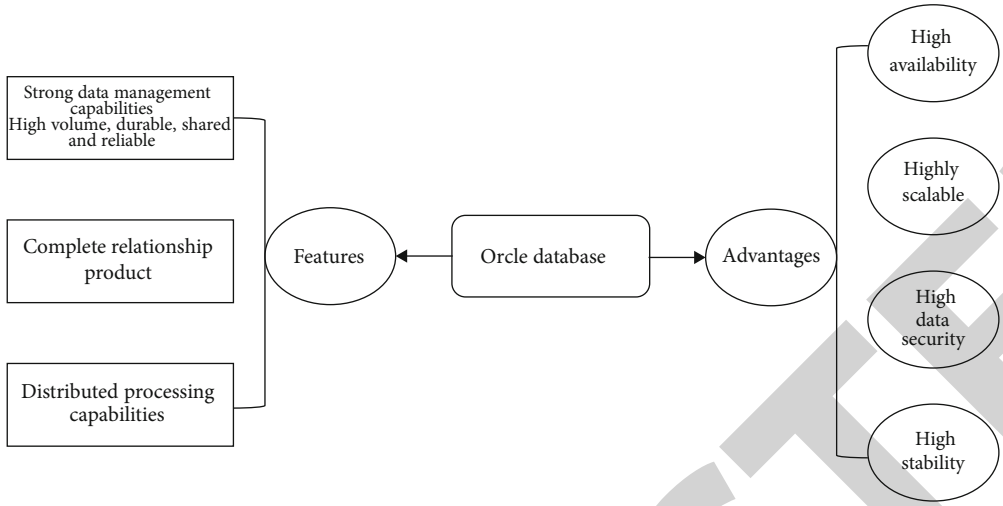

Figure 6: Features and advantages of Orcle database.

current state of Chinese e-commerce development, an analysis of its success factors and consideration of its benefits and drawbacks, an Indian scholar's paper projects future directions for e-commerce. This paper emphasizes that as e-commerce advances, it will eventually become the "standard" of business and will experience continuous growth. Lanzhou University research team stressed that the renewal of media will help the innovative development of marketing model. Some scholars point out that under the role of "Internet+", live streaming has gradually integrated into foreign trade activities, and foreign trade enterprises have begun to skillfully use live streaming platforms to help the development of digital new foreign trade. China's mobile Internet users and their proportion from 2012 to 2020 are shown in Figure 7.

Internet celebrity economy is a hot industrial form in recent years. Some scholars believe that Internet celebrities are people who become famous on the Internet because of a certain behavior or event that people pay attention to, also known as Internet celebrities. Net red uses the Internet spread fast, and far-reaching characteristics continue to develop and operate their own fan circle, with the help of a huge fan group to create traffic, in order to obtain huge business opportunities. "Internet celebrities" from a simple social behavior to a complex economic behavior, driving the emergence of a new economic model, based on technology, Internet celebrities economy can continue to progress with the innovation of Internet technology, create higher economic benefits, and add strength to the real economy. A foreign scholar believes that social media provides a new way to obtain news content, and the suggestions of social media improve the trust of media and make people expect to get more news from specific media channels. When friends who share stories on social media are perceived as opinion leaders, the influence brought by these social media will be amplified. Huang argues that the Netflix economic model is a hot new marketing model that leverages the business opportunities brought by the precise targeting and traffic of big data, while using the influence of traffic and the popularity of Netflix, and using self-media as a medium to closely connect merchants and consumers as a way to carry out marketing activities. According to the foreign research team, Netflix endorsement has become a well-liked form of content marketing for e-commerce sellers due to the widespread popularity of social media and live streaming. The article offers fresh perspectives for online merchants to assess the financial worth of a Netflix endorsement, highlighting the fact that this is a brand-new method of content marketing for e-commerce sites. Value and forecast for online retail transactions from 2016 to 2021. As shown in Figure 8.

4.2. E-Commerce and Related Live Streaming Concepts and Characteristics

4.2.1. Basic Concept of Live e-Commerce Infrastructure. Every industrial (technology) revolution will give birth to a new generation of infrastructure, and currently we are entering the era of intelligence based on 5G, big data, cloud computing, Internet of Things, etc., which requires the concept and scope of infrastructure to be redefined with the support of intelligent technology. At present, the concept of business infrastructure is rarely mentioned, but business as an important support for service production and life, especially in the era of digital economy shows the operational thinking and important functions of infrastructure, so the understanding of business infrastructure should be different from general infrastructure. Business as an important grip of general infrastructure to enable social change, there are differences in the way it performs and the role it plays at different stages. In the Internet era, especially in the mobile Internet scenario, the digital economy features prominently, and the single physical infrastructure leaps to the combination of reality and reality, leading to disruptive changes in the social economy and ecological system.

Alibaba, as the leading e-commerce company and the earliest company to test the new retail, its executives often mention the concept of business infrastructure on different occasions. For example, Jack Ma believes that business infrastructure is the core indicator of Ali, including transaction market, payment, logistics, cloud computing, and big data.

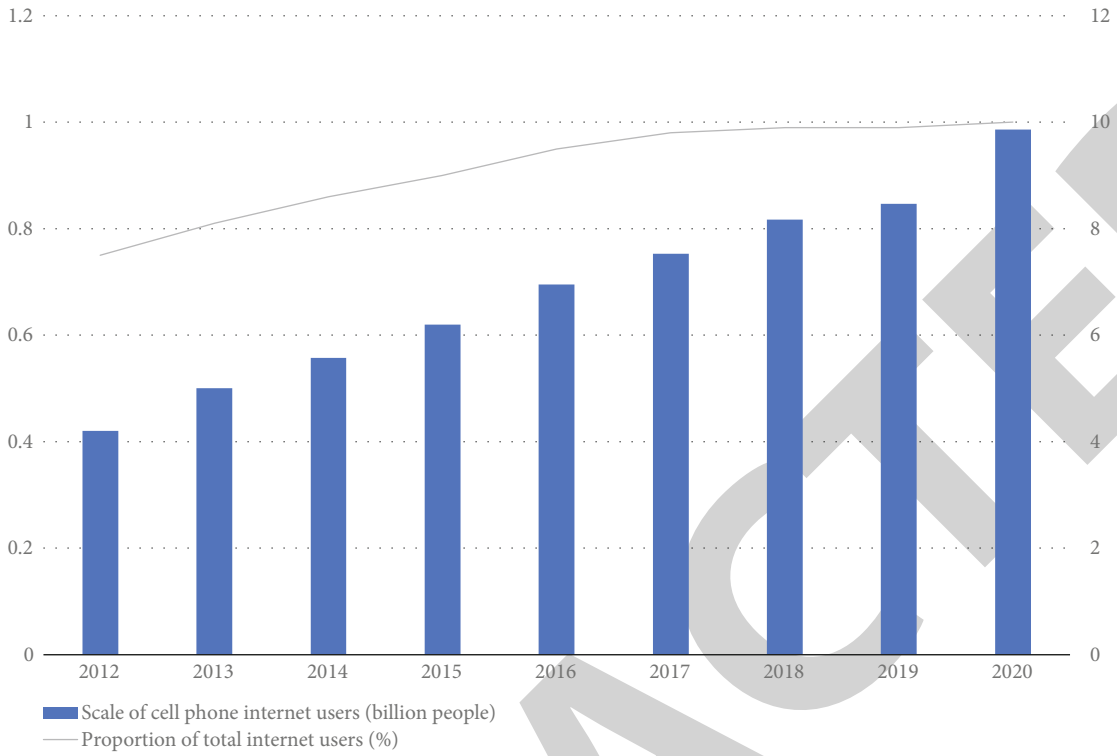

Figure 7: Mobile Internet users and their proportion in China from 2012 to 2020.

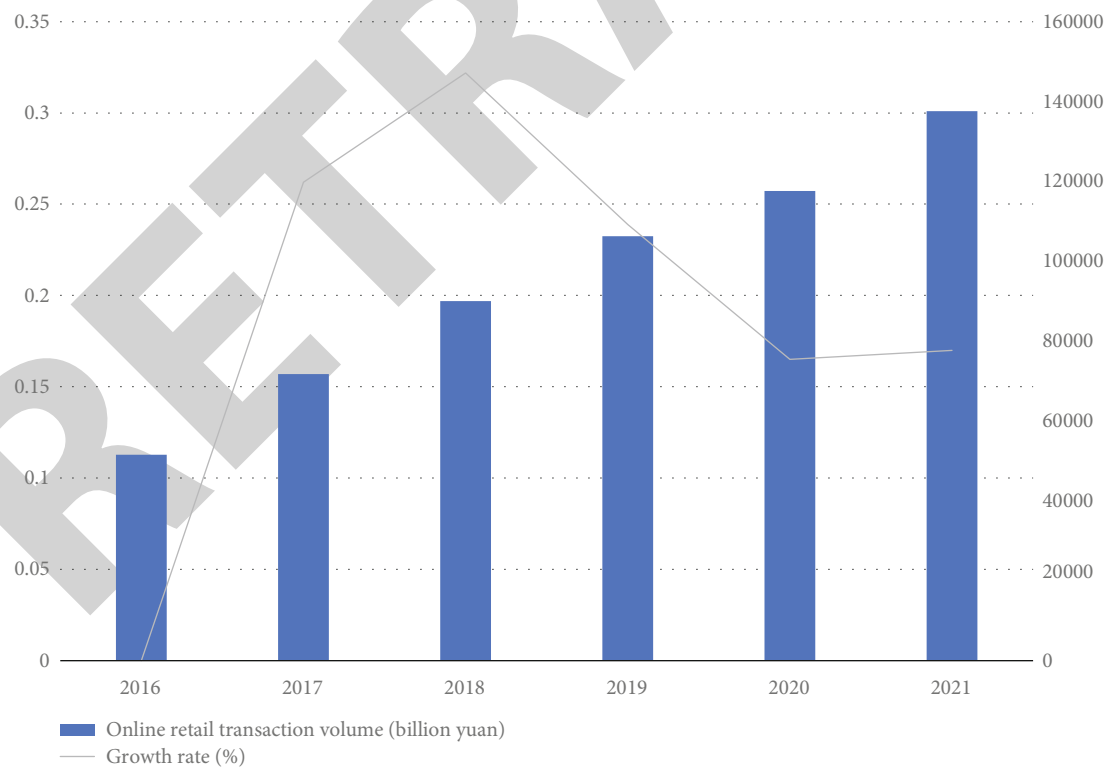

Figure 8: Online retail transaction value and forecast from 2016 to 2021.

There are also scholars, industry experts, and research institutions, among others, who have noted the issue of new business infrastructure. For example, Zhang proposed that the new business era needs new business infrastructure, mainly including three aspects of new payment, new logistics, and new information channels; Wang believes that the

Internet and logistics have become new infrastructure that can promote the integration of product flow and information flow, such as Alibaba through the e-commerce platform in accordance with the positioning of business infrastructure operators continue to cross borders, and Jindo through social links to consumers highlight the social traffic infrastructure concept. Overall, the industry's definition of the concept of new business infrastructure is fragmented, reflecting different perspectives on economic dynamics, industry development, and business nature. Alibaba, as a leading business innovation company, has been building a new business infrastructure system based on its platform, technology and resources, and executives such as Jack Ma, Zhang Yong, Liang Chunxiao, and Gao Hongbing have expressed their views on Alibaba's business infrastructure empowerment in public. The concept is expressed in a generalized manner. Some scholars and institutions also emphasize the role of new business infrastructure in empowering consumption and its basic components, such as Liuhe Consulting, which emphasizes the role of new business infrastructure in transforming both merchants and consumers' lifestyles, and Zhang Wenkui and Liuhe Consulting, which both consider e-commerce channels, mobile payment, logistics, and distribution as the main components of new business infrastructure. In addition, based on different levels of development policies and development realities, scholars have developed a multiperspective reality note on this concept.

Business is an economic activity that promotes the circulation of goods by buying and selling, and commercial infrastructure should be an infrastructure related to the circulation of goods, which serves both production and life. Overall, it seems that commercial infrastructure is a broad concept, and in a general sense, based on economic kinetic energy, commercial infrastructure can be understood as the economic form that plays the kinetic role of commercial-driven economic development, such as e-commerce showing the basic function of driving economic development; based on the industry itself, commercial infrastructure can be understood as the underlying technology and hardware facilities that support commercial development, such as electronic payment technology. Based on the nature of business, business infrastructure should be understood as an integrated business model that supports production and life services and reflects the function of infrastructure. The new business infrastructure is different from the traditional business infrastructure, and its "new" does not mean old or new but reflects the disruptive change, dynamic development, and all-round empowerment trend of business infrastructure in the digital economy. It should be noted that commercial infrastructure in the digital economy follows the logic of consumer-centric services based on retail transformation, so the understanding of the new commercial infrastructure should also tend to be from the perspective of terminal commerce. Based on the perspective of terminal business and business essence, the new business infrastructure can be understood as the underlying business system that integrates intangible and tangible facilities in the digital economy era, with digital business innovation model as the core, and efficiently supports production and life services. Compared with the traditional concept, its differences are mainly reflected in four aspects: first, breaking through the traditional commercial infrastructure mainly focuses on the underlying logic of empowering businesses, shifting to the basic logic of empowering production and life, especially life services as the core, and expanding the boundary and depth of commercial infrastructure empowerment; second, highly emphasizing the empowering effect of digital technology, embodied in a series of information technology support and application of efficient business. Third, break through the boundary of traditional commercial infrastructure mainly defined as tangible facilities, emphasize the integration of tangible and intangible facilities, and show the integrated service functions of facilities through business model innovation; fourth, break through the concept of separation of commerce and logistics and emphasize the integration of logistics into commerce to realize integrated support for production and life services.

4.2.2. Main Features of e-Commerce Infrastructure. Unlike general infrastructure, business infrastructure is closely integrated with business model. Business is a continuous evolutionary process, which relies on technology support and combines with consumer demands to continuously promote the reconfiguration of elements. The new business infrastructure is an infrastructure highly dependent on the Internet, and in general, the evolution of the business ecosystem with e-commerce as its core reflects the macrohistory of its development. Looking at the development reality in China, e-commerce as the core business has generally undergone several iterations since the end of the 20th century, and each stage demonstrates a different logic of infrastructure operation, which can be regarded as different stages of the construction of new business infrastructure.

The traditional business infrastructure is a business infrastructure with physical space as the core, and this concept also corresponds to the tangible characteristics of traditional infrastructure, while the new business infrastructure with e-commerce as the core continuously promotes the integration of functional elements. From the perspective of core elements, supported by the (mobile) Internet, the new commercial infrastructure has undergone reconstructive changes in traffic, property, logistics, payment and technology, with wide area linkage, virtual-real combination, and strong technical empowerment highlighted, showing a more powerful enabling role; from the perspective of organizational logic, the new commercial infrastructure highlights the human-centered service logic, realizing efficient, and accurate matching of supply and demand. From the perspective of organizational logic, the new commercial infrastructure highlights the human-centered service logic and achieves efficient and accurate matching of supply and demand; from the perspective of intrinsic characteristics, the new commercial infrastructure drives cost and efficiency optimization while highly reflecting the role of consumer sovereignty and satisfying consumer demands in all aspects; from the perspective of industry display, the new commercial infrastructure shows pan-innovation characteristics

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Retraction

Retracted: Software Engineering Code Workshop Based on B-RRT*FND Algorithm for Deep Program Understanding Perspective

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] A. Xu, "Software Engineering Code Workshop Based on B-RRT*FND Algorithm for Deep Program Understanding Perspective," *Journal of Sensors*, vol. 2022, Article ID 1564178, 11 pages, 2022.

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Research Article

Software Engineering Code Workshop Based on B-RRT*FND Algorithm for Deep Program Understanding Perspective

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Developers will perform a lot of search behaviors when facing daily work tasks, searching for reusable code fragments, solutions to specific problems, algorithm designs, software documentation, and software tools from public repositories (including open source communities and forum blogs) or private repositories (internal software repositories, source code platforms, communities, etc.) to make full use of existing software development resources and experiences. This paper first takes a deep programmatic understanding view of the software development process. In this paper, we first define the software engineering code search task from the perspective of deep program understanding. Secondly, this paper summarizes two research paradigms of deep software engineering code search and composes the related research results. At the same time, this paper summarizes and organizes the common evaluation methods for software engineering code search tasks. Finally, the results of this paper are combined with an outlook on future research.

1. Introduction

Developers face a large number of search behaviors in their daily work tasks, searching for reusable code fragments, solutions to specific problems, algorithm designs, software documentation, and software tools from public repositories (including open source communities and forum blogs) or private repositories (internal software repositories, source code platforms, communities, etc.) to make full use of existing software development resources and experiences and to improve the reusability of software, while reducing development costs and improving development efficiency. A study conducted in 1997 showed that code search has become the most common activity in software development activities [1]. The study showed that developers would construct an average of 12 query statements per workday to search for problems encountered. It can be seen that code search is gaining importance in software development activities. A scholar at Peking University has conducted a literature summary of work related to code search tools. The authors established a classification system to categorize code search tools in terms of code repository organization, query texts, search models, and evaluation methods [2]. Code search can be classified from search forms, such as code search based on natural language query, code clone detection, code search based on test cases, code search oriented to defect detection, and application programming interface search. The common point is to locate code files or fragments that meet user requirements from user requirements, combining information retrieval, program understanding, and machine learning techniques [3]. The framework of code understanding based on deep neural networks is shown in Figure 1.

Among them, the code search based on natural language query is closer to the actual needs of developers and is the hot spot in the current code search research. The code search task is similar to the traditional ad hoc task, but the code search task also has many difficulties, which are introduced in the next section.

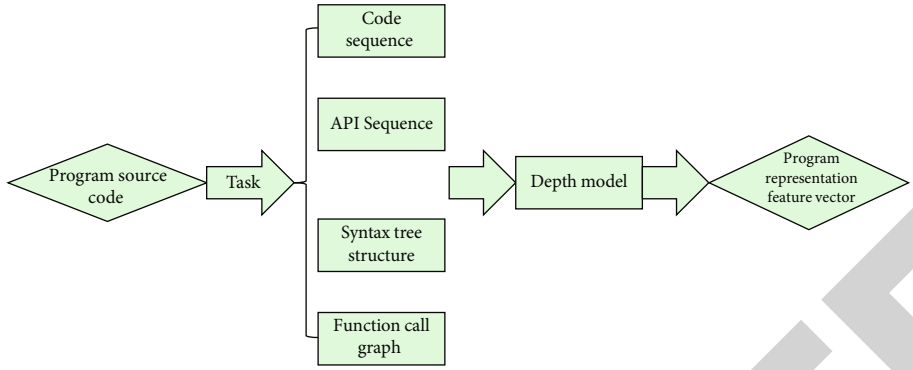

Figure 1: Deep neural network-based code understanding framework.

2. Research Background

The code search based on natural language query is closer to the actual needs of developers and is the hot spot in the current code search research. The code search task is similar to the traditional ad hoc task, but the code search task also has the following difficulties.

2.1. Cross-Modal Matching Problem. In the code search task, the query and the document are in different modalities. The query is mainly expressed in natural language form, while the target document is a source code text with program language syntax constraints, and the cross-modal semantic gap problem needs to be considered when computing the match [4].

2.2. The Query Intent Understanding Problem. The intentions expressed by queries in code search tasks are more diverse. They include user development requirements, constructive requirements to achieve a specific technical route, and API requirements to use a specific interface. It is necessary to combine software engineering domain knowledge with semantic understanding models when constructing retrieval models to understand user query requirements [5].

2.3. Program Understanding Issues. The code search model first needs to build an understanding of the source code fragment of the retrieved object. It includes the code base syntax semantics, API functional information, code structure features, and code functional characteristics. Among them, identifiers and program structure are the core of building program understanding [6].

As can be seen, the main problem faced by current code search research is how to understand program functionality and query intent matching based on program understanding, i.e., joint modeling of natural language and code fragments based on program understanding. In this paper, we present a review of recent code search research progress from the perspective of program understanding.

3. Materials and Methods

3.1. Basic Theory

3.1.1. Program Understanding. Program understanding is a key activity in software engineering, and the importance of program understanding in software engineering was clarified by the NATO Conference on Software Engineering held in 1968. Software engineers rely on understanding of programs when performing tasks such as software reuse, maintenance, migration, and reverse engineering [7].

In a collaborative development scenario, developers need to understand the software architecture and interface design patterns to develop and implement software functions, while in software maintenance, maintainers need to understand the main functions and implementation methods of existing projects as a basis for further defect checking and repair. "Understanding" is essentially a mapping from the conceptual domain of the object of understanding (e.g., text and source code) to the conceptual domain with which the subject of understanding (human, model) is familiar by means of learning. The subject of program comprehension is the whole software system or part of it and is aimed at studying how it works [8]. Program understanding tasks include constructing models at each level of abstraction from code models to application domain problems, understanding software using domain knowledge and constructing cognitive models between software artifacts and usage scenarios, and judging their role and relationships with other components by reading source code. Its ultimate purpose is to support software maintenance, evolution, and reengineering [9].

Classified according to the implementation approach, program understanding can be divided into two main approaches: analysis-based and learning-based. Analysis-based program understanding approaches rely heavily on the analyst's personal knowledge and experience, and constructing a program understanding model is equivalent to manually constructing a set of relevant features [10]. Such approaches are often coupled with specific software systems, and the relevant rules of experience are more difficult to be transferred to other projects. Also, as the size of the software increases, the resources required for analysis will increase plus rise and efficiency will decrease.

3.1.2. Deep Program Understanding. The availability of large amounts of open source code on the Internet provides sufficient data for learning-based program understanding methods. Studies have shown that program source code has properties similar to natural language, and this naturalness provides a theoretical basis for combining statistical

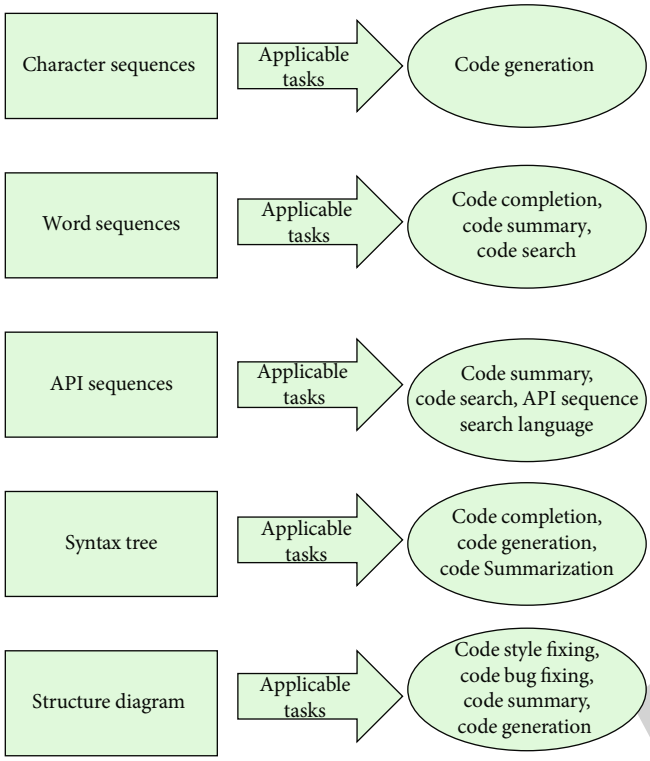

Figure 2: Software engineering code understanding representation situation.

models, especially deep models, for source code analysis and understanding [11]. Some scholars have conducted an in-depth analysis of the impact of source code localness on statistical modeling [12]. Domestic scholars have provided a detailed overview of the progress and challenges in deep source code modeling [13]. The software engineering code understanding representation is shown in Figure 2.

The deep learning-based program understanding framework, which consists of two main stages, first constructs the corresponding representation of source code text according to the different tasks and on this basis constructs the source code feature vectors by deep models and applies them to specific tasks [14].

Specifically, the program source code is first transformed into CharSequence, TokenSequence, APISequence, AbstractsyntaxTree (AST), and FunctionCallGraph (CFP) according to the task [15].

Based on this, source code different representations are used for specific tasks after being converted into feature vectors by neural networks. Source code has different representation form characteristics and applicable tasks. The modeling of programs based on word representations is similar to the modeling of natural language understanding models and is simple to implement and easy to migrate [16]. However, word-based code modeling approaches are often plagued by the OutOfVocabulary (OOV) problem due to the presence of developer-defined identifier cases [17]. Character sequence-based modeling can solve the OOV problem, but character symbol-based representations have difficulty learning word meanings and are therefore weaker in terms of representational power. The APIs contained in the code are often designed to be standardized, while the wording is more fixed, so learning for API sequences has good results in both code search and summarization tasks [18]. This is shown in Figure 3.

It can be observed that the use of word sequences alone as a representation of source code suffers from a lack of representational power, so combining multimodal approaches to model source code is gradually coming to the forefront of researchers' minds. Syntax tree-based code modeling can improve the problem of inadequate learning of program structure in sequence modeling. However, most of the existing studies use sequence sampling to obtain node sequences from syntax trees for representation, and the utilization of tree structure is not sufficient. Scholars at Northwestern Polytechnic University propose an improved method for fusing syntax tree information into code representation methods, where syntax trees are used as a parallel corpus of code sequences and modeled with natural language fragments based on alignment with source code sequences, improving the effectiveness of source code search tasks. The ability of graph neural networks to model natural language text structure has also inspired its exploration in code modeling. Source code data is easier to construct graph representations than natural language text, so program understanding models that incorporate graph structures have a better prospect.

As can be seen, deep code understanding research is the basis for many software engineering tasks, and the feature vectors from different representations can provide sufficient feature information for code search tasks. The next section defines the code search task from a deep program understanding perspective.

3.2. Research Methodology

*3.2.1. B-RRT~*FND Algorithm.* The RRT algorithm is one of the most representative sampling-based path planning algorithms, which can achieve the purpose of expanding the tree by randomly generating sampling points from the space, using the starting point as the root node, and growing from the nearest and collision-free sampling nodes in the direction of the link in a specified step, until the link between the leaf nodes and the target point is collision-free; then, the path planning is completed. The basic steps of the algorithm are as follows: step 1: given the map space M, the starting points Pstart and Pend. Step 2: Prand is obtained by random sampling in the space. Step 3: start from the nearest node Pnear point to grow toward Prand with step s and define the newly generated point as Pnew. Step 4: there is a certain probability that the sampled points will not grow along the randomly sampled point Prand but choose to grow directly to the end point Pend. Step 5: when the tree grows to Pend or the line between Pnew and Pend does not intersect with the obstacle, the feasible path σ is generated. Although the RRT algorithm has probabilistic completeness and can quickly obtain feasible solutions in space, its process of searching for solutions is blind, specifically because Prand is obtained by random sampling, which makes the tree grow

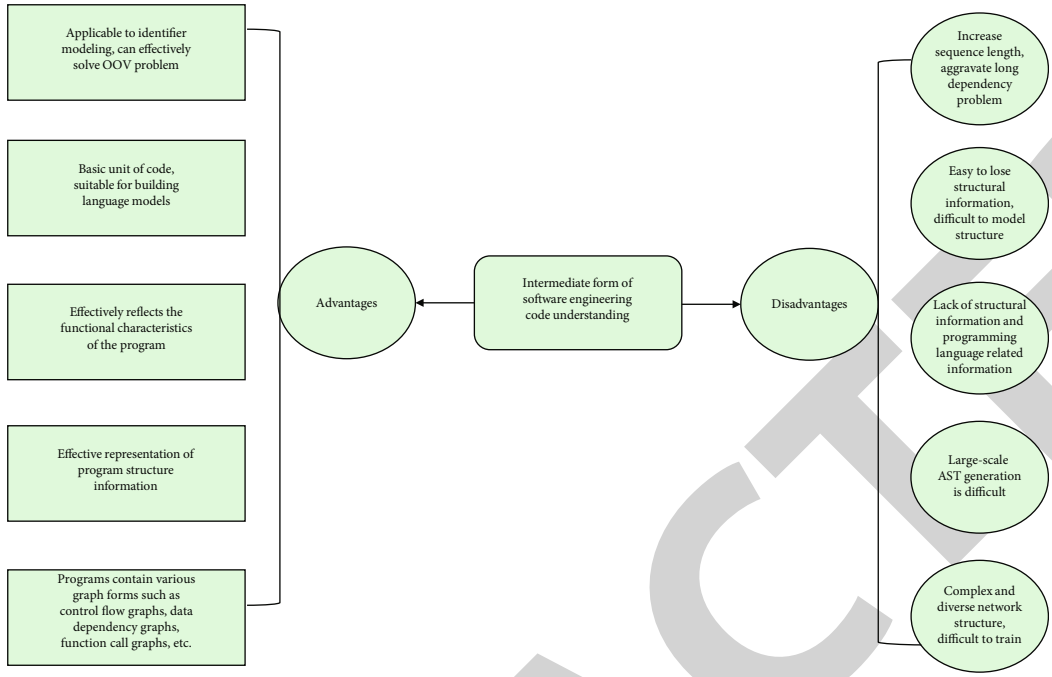

Figure 3: Intermediate form of code understanding.

in a random direction, and the algorithm lacks memorability of node expansion, leading to redundancy.

The RRT* algorithm belongs to the optimal algorithm, and the asymptotically optimal path can be obtained by obtaining enough sampling points in the update iteration. The algorithm adds two operations of parent node reselection and node reconnection: parent node reselection: with Pnew as the center of the circle, nodes in the region with R as the radius are selected as alternative parents, and the path cost with these nodes as parents is calculated, and the node that minimizes the path cost is selected as the new parent. The node with the lowest path cost is selected as the new parent and connected, and if there is a collision in the path, other alternate parents are selected. Node reconnection: take Pnew as the center of the circle, select a range with R as the radius, try to change the parent node of the node within the range to Pnew; if doing so can reduce the total path cost, then disconnect the node from its parent node and connect it to Pnew; if the connection has a collision, then give up this connection and continue to select other nodes within the range to try in turn. If the random sampling point Pn is taken exactly on the optimal path $\sigma*$ from Pstart to Pend in the space, the path cost is reduced due to Pn becoming the parent of its neighboring nodes after enough times of sampling. Since the algorithm scales up the search while the parent node reselection and node reconnection operations traverse all points in the tree, causing a huge memory burden, the search efficiency of the algorithm can be improved by fixing the number of nodes. The RRT*FN algorithm (Fixed-nodesRRT*) introduces the concept of maximum number of nodes based on the RRT* algorithm, which sets the maximum number of nodes allowed in the tree and randomly deletes a childless node except the end node when the number of nodes in the state space is greater than the preset node. The steps of RRT*FN algorithm are as follows: step 1: same as RRT algorithm step 1, step 2, and step 3. Step 2: Perform parent node reselection and node reconnection. Step 3: every time a Pnew is generated, check the number of nodes present in the space, if it is greater than the maximum number of nodes FixNodes randomly delete the childless leaf nodes that are not the last node of the path. Step 4: when the tree grows to Pend or Pnew and Pend's connection does not intersect with the obstacle, the feasible path σ is generated. Repeat step 1 to step 3 for asymptotic optimization of the path solution.

B-RRT*FND algorithm: inspired by the RRT*FN algorithm, in order to further improve the search efficiency of the RRT*FN algorithm and apply the algorithm to the dynamic environment, this paper proposes the B-RRT*FND algorithm (BidirectionalRRT*Fix-NodeDynamic), which improves the algorithm for the original RRT*FN algorithm by making the following improvements, combining the bidirectional greedy search strategy with RRT*FN algorithm is combined to further speed up the planning speed of the RRT*FN algorithm. It also makes use of dynamic update and path repair to enable the algorithm to be applied to the case of unknown and moving obstacles.

Greedy bidirectional search: the improved algorithm combines a bidirectional greedy search strategy with the RRT*FN algorithm to solve the problem of blindness in the growth of unilateral trees. The RRT*FN algorithm has no advantage over the RRT* algorithm in search speed, can only reduce the residual sampling points to avoid redundant growth, has the effect of limiting the tree size to improve the program running speed when the number of iterations is high leading to a large tree size, and is not related to obtaining path solutions quickly. With the addition of the two-way greedy search strategy, the algorithm

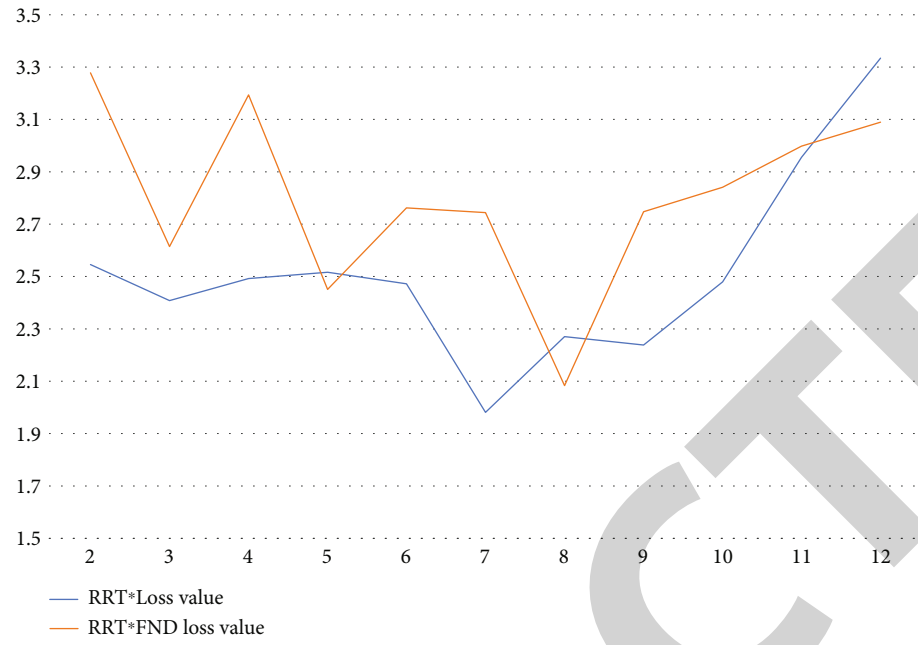

Figure 4: Comparison of RRT* loss value and RRT*FND loss value.

plans a path with more obvious directionality and can obtain an initial path more quickly. The greedy bidirectional search needs to establish two random search trees, Tree1 and Tree2, at the start and target points simultaneously, and the two trees grow toward each other, respectively, using the greedy strategy in the growth process. In this paper, the two-way greedy search strategy is combined with the RRT*FN algorithm to improve the defects of the traditional one-way random tree growth with poor purpose. Two trees are created from the starting point Pstart and the target point Pend, and each grows greedily toward the other. The green line is the starting tree and the blue line is the end tree. The black circles indicate obstacles. The nodes in the state space are generated in the order of subscripts, if the number of nodes in each tree is specified to be no more than 5.

In this paper, the RRT* loss value and RRT*FND loss value are low in each hidden layer node tree, and the total number of 11 nodes is between 2 and 12, and both loss values are above 2. The results show that the RRT* loss value and RRT*FND loss value are low, as shown in Figure 4.

In this paper, on each hidden layer node tree again, B-RRT ~ *FND loss value and RRT*FND loss value are higher, much higher than the number of nodes selected in this paper requires a total of 11 nodes from 2 to 12; both loss values are about 6 or more, and the results show that B-RRT ~ *FND loss value and RRT*FND loss value are higher, as shown in Figure 5.

In order to verify the effectiveness of the algorithm in this paper, the BRRT*FND algorithm is compared with other algorithms under three maps, and its performance indexes are evaluated. To facilitate the simulation analysis and to take into account the reasonableness, because the RRT class algorithm is based on random sampling, there is chance in the simulation process, and each measurement result may cause large differences due to different sampling point locations. In order to exclude the influence brought by chance, this paper conducts 50 independent experiments for each case and collates the results for comparison and analysis.

The two-way algorithm has certain advantages in fast solution finding, and the overall path cost is further reduced due to the improved algorithm using a two-way greedy search strategy. Since the B-RRT* algorithm, the RRT*FN algorithm and the B-RRT*FND algorithm are all optimal solution algorithms; the iterative process path solution parameters of the path solution are collated in this paper, as shown in Figure 6.

It can be seen that the path solution length and search time of B-RRT*FND algorithm are due to the other two algorithms. The length of the B-RRT* algorithm after 500 iterations is basically the same as that of the B-RRT*FND algorithm, but because it does not have a fixed number of nodes, the running time tends to increase concisely with the number of iterations, and after 1500 iterations, the running time of the improved algorithm and the number of iterations are approximately linear. At 3000 iterations, the B-RRT* algorithm takes 36.117 s, and the B-RRT*FND is 29.221 s. The algorithm performance comparison (II) is shown in Figure 7.

3.2.2. Main Evaluation Method. Set (Ω, ζ, P) is a conceptual space, and x is the set of all wandering variables on the space involved. The risk measure ρ is a mapping x from a x_ρ subset of $R$to the real numbers, denoted as $\rho : X \in x_\rho \leftrightarrow \rho(X) \in R$.

First define the g function called distortion function (distortionfunction) $g : [0, 1] \longrightarrow [0, 1]$ if it is a monotonically nondecreasing function and satisfies$g(0) = 0$, $g(1) = 1$.

Next, define the $\rho_g : x \longrightarrow R$ risk measure, often called distortionriskmesure if $\rho_g(X)$ satisfies

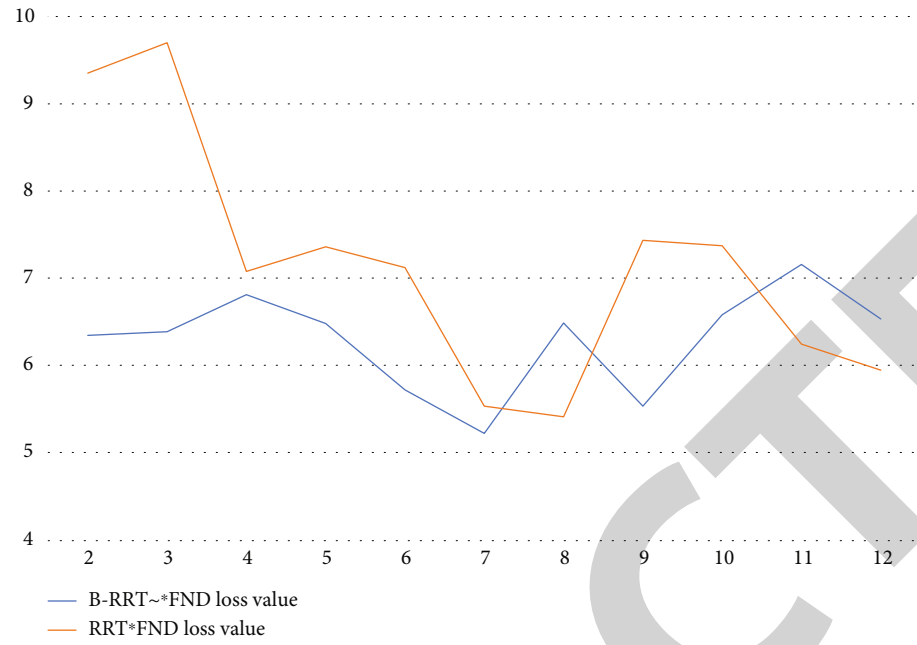

Figure 5: Comparison of B-RRT ~ *FND loss value and RRT*FND loss value.

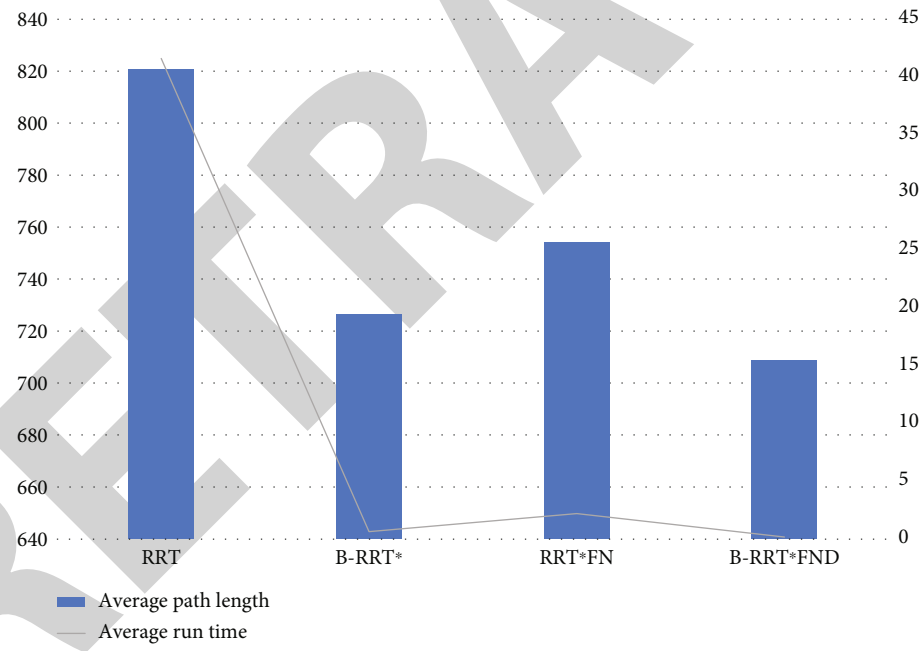

Figure 6: Algorithm performance comparison data (I).

$$\rho_g(X) \coloneqq \int_{-\infty}^{0} \lg\left(S_X(x)\right) - 1)dx + \int_{0}^{\infty} g(S_X(x)))dx, \quad X \in x, \tag{1}$$

where g is the distortion function, in which $S_X(x) = P(X \succ x)$, X is the tail distribution.

The X assumption is that the total risk faced $f : [0,\infty) \longrightarrow [0,\infty)$ by the insurer $f(X)$ is the partition function, representing the insurer transferring part of the risk faced by itself to the reinsurer. The reinsurers charge the insurer for the insurance premiums to supplement the risks they bear because they assume a portion of the insurer's risks. In this paper, we assume that the reinsurance cost criterion has the following form:

$$\mu_r(f(X)) = \int_0^{\infty} r\left(S_{f(x)}(x)\right)dx. \tag{2}$$

Without loss of generality, we assume r that it is not a function, that is, zero almost everywhere, and that the total risk an insurer has to face is the residual risk it will face plus

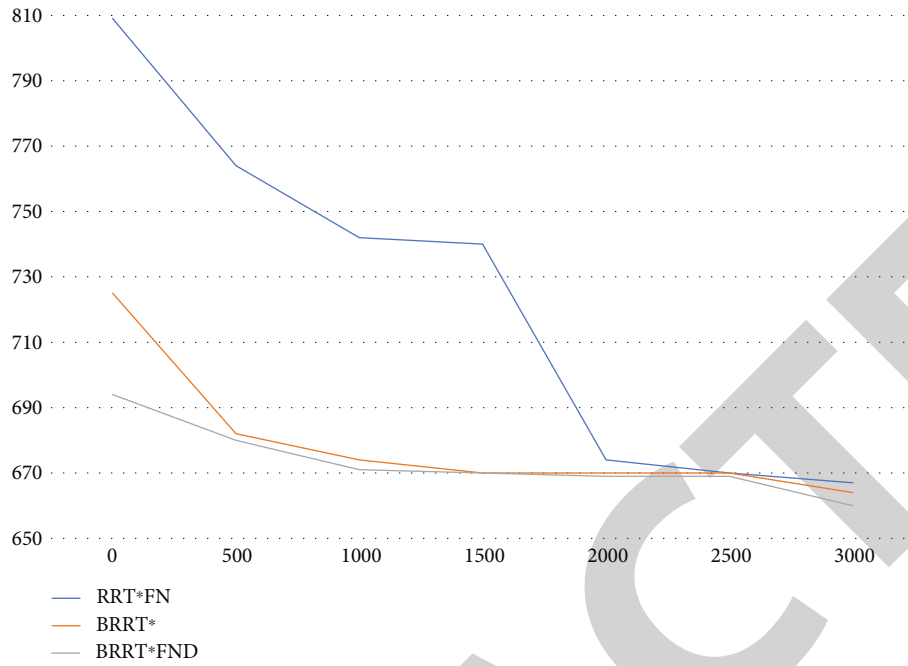

Figure 7: Performance comparison of the algorithms (II).

the cost required to transfer the risk. Expressed in terms of the formula can be expressed as

$$T_f(X) = X - f(X) + \mu_r(f(X)). \quad (3)$$

The basic algorithm theory BP algorithm theory process mainly includes the process calculation of linear propagation of output signal deviation forward and backward and linear propagation of output signal error forward and backward and reverse which are two process calculation processes. That is, the signal error can be adjusted according to the two input directions from the actual input signal direction to the actual expected signal output, respectively, to calculate the signal output, from the direction of the real expected signal output and then to the real expected input direction of the two directions, respectively, to calculate the signal error to adjust the signal error weight range and error threshold. In the study of the propagation method after the forward superposition of the signal, the input node signal is mainly the node on the actual output of the signal after the inverse superposition through the role of the hidden layer, and the actual output node signal can be generated through the nonlinear transformation process [19]. If we find that the actual signal output node position does not coincide with the actual output node direction position of the actual input node expectation signal, the process of backward feed-back propagation method for signal error compensation will be easily generated. The principle of error input signal back propagation processing system is that the system will automatically back propagate its various output signals or error information values to each error input layer of the system through the hidden layer nodes layer by layer and will sequentially transfer its output error signal values to the nodes on each layer corresponding to all other layers of the system error input signal elements, with the system in each layer of the system nodes obtained. The output error input signal values obtained by the system at each layer node are used as the basis for its calculation to automatically adjust the weights among the system's error output signal elements [20].

Neural network is essentially a nonlinear predictive model and, as its name suggests, an algorithm that mimics the human and animal nervous systems for computation. It is based on imitating the neural network system of human and animal-like brains to perform calculations and then to process the content of each module. Neural network algorithm is a derivative of data mining technology, which is one of the types of data mining technology that can be used for big data mining, such as analysis, classification, aggregation, and other data mining functions. Its advantages and disadvantages are very clear; the first advantage is that it is extremely resistant to interference, and the second is that it is capable of deep learning and better memory in a nonlinear situation and can handle more complex situations. At the same time, it has two disadvantages. First, its computation and processing results are low-dimensional and cannot be adapted to a high-dimensional environment, so it has a hard-to-interpret nature. The second is that whether it is supervised or unsupervised learning, it requires a long learning time, and the data is collected using a more traditional neural network approach.

In this paper, we use fuzzy neural networks. This type of neural network (FNN for short) is first, a deep combination of fuzzy theory and neural network algorithms. In the process of data mining and information processing by neural network algorithms, fuzzy theory is incorporated to improve the mapping and the relevance of mathematical relationships. The efficiency of supervised learning and unsupervised

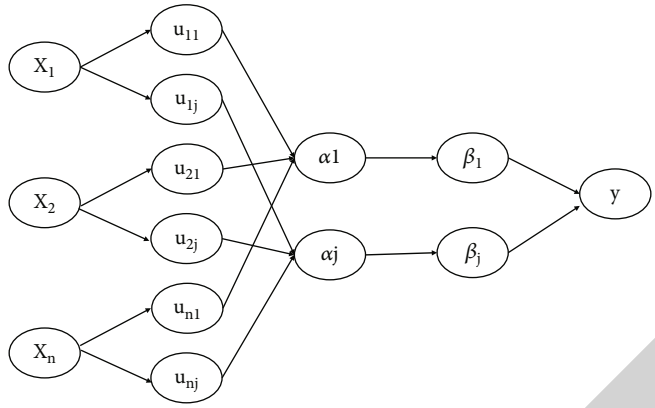

Figure 8: Fuzzy neural network.

learning is better improved. The algorithmic formulas of such neural networks and the related structural diagrams are more commonly used and common and can be found in general textbooks. This type of neural network is shown in the figure; it goes through five levels in the process of training and supervised and unsupervised learning; at the beginning of the two levels, as the level increases, the range of calculations required will be doubled, but as it enters the third level and enters the fourth level and enters the fifth level, the content of calculations will gradually decrease until it becomes one. Of course, this type of graph is first tested for dimensionality at this node in the input layer when the input is made. The specific value assumes that the dimension value is n and the node that needs to be input is n. Depending on the number of nodes needed, it is passed all the way to the layer of the dimensionality function and the related layer of further computed functions, as well as finally to the output layer. This type of fuzzy theory combined neural network has the same nature as the wavelet neural network and the neural network combined with the generalized theory, which both use the traditional gradient form of computation downward to calculate the centroid of the affiliation and the associated required width value and the final output value and the weights that we need. This is shown in Figure 8.

4. Results and Discussion

4.1. Software Engineering Code Search and Document Search. Code search is a cross study of information retrieval and program understanding, similar to document search techniques, and they have more commonality in various techniques such as query understanding, document indexing, and document sorting. However, from the perspective of the search object, due to the characteristics of source code itself, the understanding of code includes two aspects, i.e., the usage scenario of code and the principle of code algorithm. Taking "bubble sort" as the query, the results of document search and code search can be seen that the document search results often contain the original keywords and a series of concepts around the keywords and combinations. In the code search results, the focus is on the specific implementation of the algorithm and the correctness of the code. The core difference between the two lies in how the understanding of the document (code) is achieved. At the same time, matching code to user intent based on characteristics such as source code functional characteristics, application scenarios, and how the functionality is implemented is the biggest difference between the two search approaches. From a formal point of view, Q is the query text, and C is the source code fragment. As can be seen, the difficulty of the code search task is to establish an understanding of the source code fragment and, on this basis, to achieve a match between the user's query intent and the functional semantics of the code fragment. In traditional information retrieval model-based approaches, the code is usually treated as an ordinary natural language document, and the similarity between the user query and the code document is finally calculated by combining the natural language model with vectorization after simple word separation, deactivation, and stemming.

A research team in the UK proposes a method based on textual regularization for traceability between code and documents. Another foreign scholar introduces method name information into the retrieval model to enhance the performance of code retrieval results and combines API understanding to improve the code search system based on information retrieval, whose implementation is simple and straightforward and is a common research baseline. A scholar in Xi'an introduced the combination of topic model and Tfidf model into source code and query representation to improve the accuracy of query and code matching. An Italian research team recategorized code search features and reassigned feature weights according to different semantic categories to improve the retrieval effect. Domestic scholars proposed a code search method combined with ranking learning. Some other scholars further expand the code search feature system on this basis and combine it with ranking learning. Deep code search research then combines deep program understanding research to construct retrieval models. Some scholars have pioneered the problem of the semantic gap between source code and natural language. The query text and code fragments are obtained as feature representations by natural language models and program understanding models. After obtaining feature vectors, matching relations are constructed by deep models.

Natural language model part, word representation, word2vector model, glove model, and fasttext model are

commonly used for representation; contextual representation, Elmo model, Bert model, etc., are commonly used to model sentences directly to obtain representation.

In the part of matching model, domestic play scholars jointly studied the combination of ranking learning training target and depth model, i.e., neural information retrieval model. In addition, domestic scholars have summarized the loss function in the neural retrieval model, and methods such as contrast learning sorting (contrastive learning) and ternary sorting (triplet loss) have gradually received attention, combining reinforcement learning to improve query understanding and thus retrieval effect. In the section on procedural representation models, the UK research team has summarized and categorized them in more detail. Early research treated code fragments as ordinary text and combined with natural language modeling methods to model word sequences and API sequences; some subsequent work gradually paid attention to code structure properties and proposed code structure modeling methods combined with abstract syntax trees, and the stronger graph structure of source code makes recent research on source code modeling combined with graph neural networks gradually gaining attention.

4.2. Deep Software Engineering Code Search. This section compares current code search research progress from the perspective of deep program understanding models. In terms of paper selection basis, this paper uses code search and code retrieval as keywords for searching, covering software engineering, natural language processing, neural computing, and other fields. Finally, more than 40 papers related to deep code search were collected from related conferences, journals, and prepublication platform arXiv. Based on this, case study papers, system design papers, and research papers without clear evaluation metrics were excluded for this paper, leaving 27 papers for the final summary.

The analysis dimensions include source code representation, deep model structure, data set used for model evaluation, and evaluation metrics. The source code representation is planned from the perspective of deep program understanding, mainly including word sequence representation, API sequence representation, tree structure (mainly abstract syntax tree), and graph structure (function call graph, syntax tree subgraph, etc.). The structural aspects of deep models include convolutional networks (CNN), recurrent networks (LSTM), transformer, attention mechanisms, etc.

A Russian scholar has made an early exploration of deep code search, which firstly studied the search and generation of APIs and on this basis proposed the deep code search model Code NN, which laid the basic framework of deep code search model. In China, scholars in this field combined word vectors to model source code in an unsupervised way, and the code text was processed into word sequences, and then, the chapter representation was constructed by word vectors, and matched retrieval was realized on this basis. Later on, some scholars further studied the semantic gap between natural language and APIs in detail on this basis.

Starting from the work of Russian scholars, a series of attempts have been made to apply different deep model architectures to the code search task. Domestic scholars have initially tried to introduce attention mechanism into code matching computation by constructing multilayer attention networks using CNN to capture the deep semantics of source code. Another Japanese scholar applied twin networks to code search tasks to enhance the matching ability between queries and codes. Indian scholars separate keyword matching and syntactic pattern learning to propose an adaptive deep code search model with stronger generalization over a new codebase. Kunming scholars, on the other hand, applied adversarial learning to the training process to improve the matching between code and query text.

The pure sequence modeling approach is difficult to utilize the structural information of the source code, and domestic scholars are the first to use abstract syntax trees to informationally enhance the code representation. Then, the semantic dependencies in the source code are modeled by combining syntax trees on this basis. Finally, self-attentive networks are used for code search for the first time, on which the sequence information and structural information of source code are modeled uniformly in combination with self-attentive networks.

The graph is a prevalent structure in source code, and Yangling County scholars construct subgraphs from syntax trees to model the relationships between different nodes in the code. After that, the query and code feature vectors are mutually augmented using relational graph convolutional network modeling to finally improve the retrieval effect. Then, different representations of the source code are considered as multimodal tasks, and the code sequences, syntax trees, and graphs are fused to model the semantic representation of the code. The final result achieves SOTA effect, which confirms the practical effectiveness of fusing sequence and structural semantics on code understanding tasks.

Pre-trained models have also achieved success in various tasks in the field of natural language processing. Some researchers have also started to focus on the effect of source code pretraining. Domestic scholars combined with the contrast learning training paradigm to train Bert models on code text; foreign scholars focused on Python code for Bert model training and proposed the CuBert model. Based on this, domestic researchers added code structure to the training process and proposed GraphCodeBert, which combined with graph structure to enhance transformer's expressiveness when pretraining code. In contrast, foreign scholars have verified the effectiveness of the CodeBert and other models on specific code comprehension tasks by using a code search task with the training model. The results show that transformer-based pretrained language models also have good results on code comprehension tasks.

4.3. Dataset and Evaluation Methods

4.3.1. Evaluation Metrics. The evaluation metrics for the code search task are consistent with those for the information retrieval task and mainly consider two aspects of the results, namely, the relevance of the retrieved results and the ranking order of the relevant results. The precision P@K calculation method is relatively simple and measures

the proportion of the number of relevant documents in the retrieval results to the retrieval results, where K indicates the number of documents obtained in one retrieval process.

Recall R@K is also simple and measures the number of relevant documents in the search results as a proportion of the overall relevant documents, where K indicates the number of documents obtained in a single search. As can be seen, the precision and recall metrics measure the ratio of relevant documents in the top K search results. MeanReciprocalRank (MRR) introduces the order of relevant documents in the results for result evaluation. The average precision (AveragePrecision) combines precision and document order, where m denotes the total number of relevant documents in the current search results and N denotes the total number of search results.

The discounted cumulative gain (DCG) introduces the relevance rank into the evaluation. The normalized discounted cumulative gain (NDCG) metric is normalized using the DCG score of the best ranked result. In addition to the above metrics, there is also Frank evaluation describing the order of the first correlation result in the search list in the list.

4.3.2. Evaluation Dataset. In this paper, we comb through the code search research work from 2016 to the present and summarize the datasets used to evaluate the effectiveness of the model. In terms of selection criteria, the dataset must be publicly available, while at least two or more works have used the dataset to evaluate the model.

The code search commonly used evaluation datasets is more involved, of which a total of seven works are involved. In terms of dataset construction, the current work focuses on constructing large-scale code snippet-natural language text combinations as training data by automated extraction. The validation data is constructed based on automatic annotation combined with negative sampling methods. The model evaluation uses common code search questions as queries, and fine-grained annotation is performed on the constructed codebase.

According to the data annotation division, among them, CSN and ROSF data were strictly annotated with relevance levels; DCS, NCS, and CosBench first screened the natural language queries and later annotated relevant code snippets on the codebase.

According to the evaluation metrics, CNS and ROSF can be evaluated using NDCG; StaQC is mainly combined with text classification metrics; the remaining datasets are mostly evaluated using MRR, P@K, and Frank metrics.

According to programming languages, the DCS, NCS, ROSF, and CosBench datasets mainly contain Java programming language code data (covering Android). The CoNaLa data, on the other hand, combines Stackoverflow community data mining and manual annotation to build data containing Java and Python programming languages. The StaQC dataset mainly contains annotation results in both Python and SQL. The CodeSearchNet dataset contains Java, Python, Php, Ruby, Go, and JavaScript, covering the widest range of programming languages.

According to the task division, StaQC converts the code search task into a related document classification problem, so it can be studied in combination with text classification methods; the CSN and ROSF data have sufficient annotation level information and can be studied in combination with ranking learning methods; the code fragment-natural language combinations contained in the rest of the dataset can be used for code summarization tasks as well as code search studies based on summarization techniques.

4.3.3. Comparison of Results. In this section, based on the introduction of datasets and evaluation metrics, recent experimental work on code search is sorted out from the perspective of model effectiveness, focusing on deep model-based code search methods. The evaluation metrics then cover recall, precision, MRR, MAP, and NDCG. For statistics, the relevant literature baseline of the proposed dataset is bolded in the literature column accordingly. Some datasets, such as the StaQC dataset, were proposed using classification metrics as baseline, so they are not indicated here.

In this paper, the results are organized by dataset, related literature, and evaluation metrics. From a dataset perspective, the StaQC dataset is the most widely used and relatively influential. The experiments on the DCS dataset are relatively more adequate, and the different literature needles basically cover all evaluation metrics. From the perspective of evaluation metrics, MRR metrics are currently commonly used in code search model validation. And from the programming language perspective, the programming language that has been studied more is Java.

4.4. Software Engineering Code-Related Perspectives. Code search research is gradually gaining attention from the academic community. In this paper, recent progress in code search is reviewed from the perspective of deep program understanding, and the problem can be studied in the following aspects in the future: (1) stable and reproducible evaluation methods: most of the current studies do not open evaluation datasets, and the open datasets have problems such as inconsistent labeling. It is shown that the problems of dataset and open source code make the reproducibility of deep model results problematic. Future research should try to build consistent and clear datasets and evaluation methods and platforms to facilitate code search research. (2) In-depth study of program representation techniques: source code understanding and modeling is the key to the code search task. Most models use sequence modeling for feature extraction representation of source code, and a few works simply stitch and fuse tree and graph structure data to introduce code structure information. Combining graph neural networks for more in-depth structural modeling of code can be attempted in future research. (3) Multimodal source code modeling approach: the source code consists of identifiers and programming language-specific keywords. The programming language-specific keywords provide the structural information of the code, while the code identifiers provide more adequate natural language information. The two modal data can be combined in future research to model the structural semantics as well as the natural semantics of the code in a unified way, which can then be used for code

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Research Article

Analysis of Nomadic Civilization in Northern Grassland in Plastic Arts Based on Deep Learning

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In this era of rapid development, the exchanges between countries are increasing rapidly, which leads to the integration of multiculturalism and its impact on the local culture, making it diluted. Taking the plastic art features of the nomadic civilization in the northern grasslands as an example, the plastic art features of the nomadic civilization are very rich, including color, texture, shape, and local characteristics; the use of traditional methods will lead to poor feature effects, and it is difficult to obtain high-level information. There will also be problems with image recognition. With the hot development of deep learning, for these problems, its advantages and characteristics are introduced and applied to the characteristics of plastic arts, and a deep and shallow network is constructed as its input and feature recognition, which solves the problem of image feature recognition. At the same time, the convolution idea is introduced to enlarge its features, which is more conducive to feature recognition, extraction, and analysis. For the neural network model of deep learning, the traditional optimization algorithm is changed to the Adam optimization algorithm, which solves the problem of decreasing accuracy, improves the accuracy of prediction, and makes it more stable. From the final experimental results, it is not difficult to find that the feature algorithm greatly improves the accuracy rate under different noises, and the time consumption of the algorithm operation is also reduced. The traditional algorithm of the deep learning neural network model is changed to the Adam optimization algorithm, which also improves the prediction accuracy and makes it more stable. In the future development, the unsaturated function can be used as the activation function to optimize or change the model feature algorithm to make the model easier to build and have better training effects.

1. Introduction

In the context of the Internet, there is hot development based on deep learning and neural networks [1–5], making it penetrate into various fields [6–10]. Because it has many excellent features, such as a huge database as a support, it can learn through layer-by-layer and feature abstraction, and it can imitate the distributed representation of human knowledge data. These advantages are exploited in the recognition, extraction, and analysis of image features. In particular, for the northern steppe nomadic civilization [11–15], its plastic arts are very rich, including color, texture, shape, and local features, and deep learning can replace traditional methods to build deep and shallow networks as its input and feature recognition, which solves the problem of image feature recognition. At the same time, the convolution idea is introduced to enlarge its features, which is more conducive to feature recognition, extraction, and analysis. In this paper, the feature algorithm and the traditional optimization algorithm are changed to the Adam optimization algorithm, which improves the accuracy of the algorithm and reduces the calculation time of the algorithm. At the same time, it also solves the problem that the accuracy of the model decreases in the process of feature extraction and improves the prediction accuracy, making it more stable.

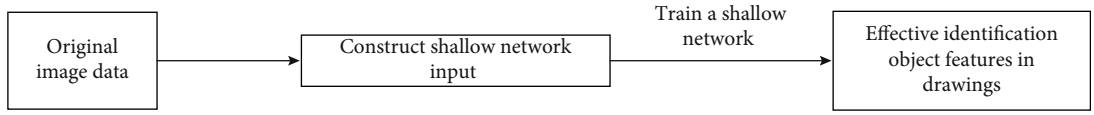

Figure 1: Shallow network input and feature recognition.

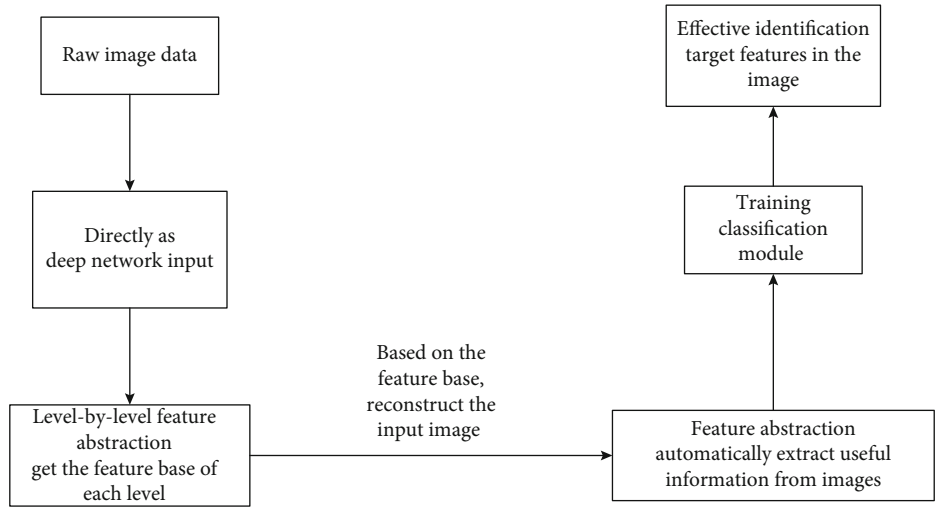

Figure 2: Deep network input and feature recognition.

2. An Overview of the Plastic Art Features of Deep Learning

With the in-depth study of the cultures of various ethnic groups, special attention is paid to ethnic minorities, including the northern grassland nomads, and the characteristics of their plastic arts are analyzed. With the hot development of deep learning, its characteristics are integrated into feature extraction and analysis. In order to solve the problem of image recognition, deep and shallow network input and feature recognition processing structures are generated. At the same time, the convolution idea of deep learning is introduced to amplify the color, texture, shape, and local characteristics of the plastic parts of the northern nomadic civilization, which is convenient for machine identification, extraction, and analysis.

2.1. Convolutional Neural Networks for Deep Learning. With the in-depth research of deep learning, its advantages and characteristics are gradually enlarged, making it penetrate into more and more fields. Among them, for feature extraction, based on the method of deep learning, the extracted plastic art features are used for retrieval through the idea of convolution. There are three methods: one is the hybrid method, that is, in the CNN network, wherein the image area is inputted from the input layer of the network, and then, feature extraction is performed on the CNN network; the second is the generative method, whose structure can describe the top-level related characteristics of the network input data; the third is the discriminative method, which can perform classification, discrimination, and strengthening.

Deep networks rely on big data to make their learning and abstraction very superior. Through layer-by-layer learning and feature abstraction, the initial input is transformed into the representation of abstract features [16], enabling better recognition and classification of image features, because it can imitate the distributed representation of human knowledge data and then realize the abstraction of high-level features from primary features. Moreover, the feature outputs of each layer of the deep network are σ processed by functions to achieve nonlinear feature dimension reduction. The sigmoid (σ) function in the article is used as the activation function of the model, and the advantages are continuous and smooth. In this paper, for the hidden layer neuron output, a real number, can be processed to the last (0, 1) interval. Its function definition is

$$f(x) = \frac{1}{1 + e^{-x}}. \tag{1}$$

Range is (0, 1), where the derivative of the function is

$$f'(x) = \frac{1}{1 + e^{-x}}\left(1 - \frac{1}{1 + e^{-x}}\right) = f(x)(1 - f(x)). \tag{2}$$

Function characteristics are as follows: when $x = 10$ or -10, $f'(x) \approx 10$; when $x = 0$, $f'(x) = 0.25$.

Among them, what is interesting is that in order to solve the problem of image feature recognition, shallow and deep network input and feature recognition structures have been proposed successively [17], as shown in Figures 1 and 2.

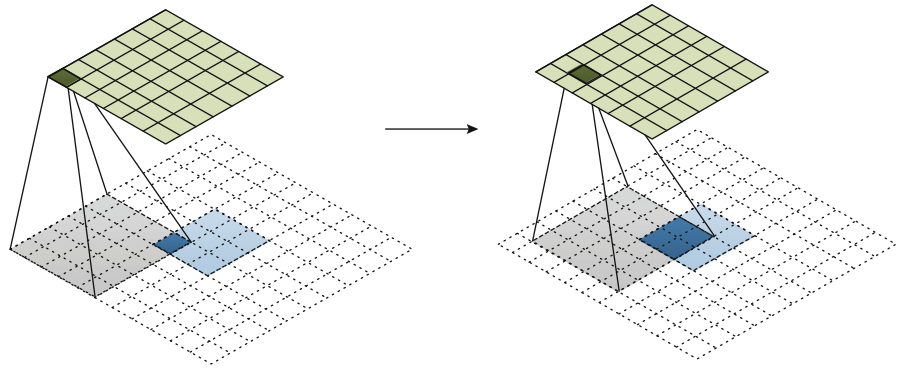

Figure 3: Transposed convolution acquisition process.

By comparing the structure diagrams of the two, it can be seen that the input and processing mechanisms of the shallow and deep networks are significantly different, and the normal operation of the shallow network requires manual feature extraction. The deep network is to gradually complete the reconstruction of image features in the absence of artificially extracted features.

Introduce the idea of transposed convolution, change the multiplication relationship between the matrix and the vector, and combine the eigenvectors decomposed by the input feature with the convolution kernel to form the transposition of the original matrix. In this way, the addition vector of the relevant eigenvectors can be obtained. That is, we zoom in on the feature. Figure 3 shows the process of transposing convolution for up-acquisition.

2.2. Characteristics of Plastic Arts of Nomadic Civilization in Northern Grasslands. In view of the premise of deep learning, the traditional identification and extraction of the characteristics of nomadic plastic arts in the northern grasslands has changed due to the introduction of deep learning, that is, using layer-by-layer pretraining to build a convolutional neural network and adding multiple hidden layers to improve computer performance. And other types of terminal equipment are used to identify and extract its features, obtain more information, and finally filter the obtained feature information through step-by-step abstraction, thereby reducing various environmental and human interferences.

Among them, for the nomadic plastic parts of the northern grasslands, including ethnic buildings, ethnic costumes, murals, decoration designs, unique ethnic characters and calligraphy, carvings, etc., for these distinctive artistic features that are different from the Central Plains culture, more information is needed during extraction. Different features of each region should be classified and extracted to ensure that this feature information can be completely extracted. The characteristics of plastic arts are divided into the following:

(1) *Color characteristics*: for the northern grassland nomadic democracy, with regard to its clothing, utensils, modeling artworks, etc., all have extremely rich colors, and there are various color mixing and matching. When extracting them, the color moment, color histogram, and color aggregation vector, further analysis of these features is required

Among them, the color moment for plastic art feature extraction is to describe the color distribution by calculating the moment, which is a simple and efficient color feature expression method. The advantage of this feature extraction method is that it does not need to quantify the color space inside the image area, and the obtained feature vector has a low dimension. The disadvantage is also obvious; that is, the feature retrieval efficiency of this feature extraction method is low, so it is usually used to filter images in practical applications to reduce the scope of retrieval. Its extraction process is as follows:

$$\mu_{\mathrm{i}} = \frac{1}{N}\sum_{j=1}^{N} p_{i,j}, \tag{3}$$

$$\sigma_i = \left(\frac{1}{N}\sum_{j=1}^{N} p_{i,j} - \mu_{\mathrm{i}}\right)^{1/2}, \tag{4}$$

$$s_i = \left(\frac{1}{N}\sum_{j=1}^{N} \left(p_{i,j} - \mu_{\mathrm{i}}\right)^3\right)^{1/3}. \tag{5}$$

Among them, $p_{i,j}$ represents the j-th color component of the N-th pixel of the i image, and j represents the number of all pixels in the image.

(2) *Texture features*: texture features can distinguish the differences between ethnic clothing and craft decorations, including the color of clothing, roughness of fabrics, shape, stripes, color matching, and surface smoothness of decorations and crafts. It is characterized by calculating a value in the image and quantifying the feature of the grayscale change in the image area. Generally, there are two ways to express texture features: one is the cooccurrence matrix, which describes the texture features by the relativity of the image gray space and the other is the local binary pattern (LBP) [18]. Among them, the local binary mode mainly obtains image texture features

by comparing the size of the LBP operator and its field

For the spatial grayscale cooccurrence matrix in texture features, it starts from pixels whose grayscale is $n * n$, and the statistical i distance from is

$$\sigma = (dx2 + dy2)^{1/2}. \tag{6}$$

Grayscale is the j pixel, the probability of occurrence is $P(i, j, \sigma, \theta)$, and its mathematical expression formula is as follows:

$$P(i, j, \sigma, \theta) = \{[(x, y), (x + dx, y + dy)]|f(x, y) = i, f(x + dx, y + dy) = j\}. \tag{7}$$

The local binary pattern in the image texture feature is a description of the operator of the local texture feature of the image. The scene is also very broad. Its specific expression process is as follows:

$$\mathrm{LBP}(x_c, y_c) = \sum_{p=0}^{p-1} 2^p s\left(i_p - i_c\right). \tag{8}$$

Among them, (x_c, y_c) represents the coordinates of the center pixel, in which p is the first p pixel of the i_p field, which represents the gray value of the field pixel; i_c represents the gray value of the center pixel; and $s(x)$ represents the sign function, as shown below:

$$s(x) = \begin{cases} 1, & x \geq 0, \\ 0, & x < 0. \end{cases} \tag{9}$$

(3) *Shape feature*: for the shape feature of the image, there are two main extraction methods: one is the contour feature, which [19] extracts the edge information of the overall image contour, and the other is the regional feature, which is the shape features are extracted

(4) *Local features*: generally, global features are used for retrieval. The disadvantage is that the false detection rate is high. Therefore, local features are used for retrieval based on this to improve the accuracy

However, before the feature extraction of plastic arts, environmental factors, such as national clothing deformation, partial occlusion, wrinkles on clothes, lighting, and noise, make the pictures that need feature extraction blurred, with uneven lighting distribution, distortion, etc. problems, so that the feature information is damaged, the extracted features are incomplete, etc. In order to solve this problem, it is necessary to preprocess the image, so that the image before processing can be restored to the shooting environment as much as possible, and the complete information can be retained as much as possible. The processing method is as follows.

2.2.1. Image Bilateral Filtering Processing. This method mainly removes redundant noise in images (including video files) while ensuring that the graphics files are not overly distorted. According to the actual situation, reasonably reduce the white noise area in the target image and improve the recognition accuracy.

However, high-pass filters are processed in high dimensions, so we all need to introduce bilateral amplification circuits to incorporate spatial information and the degree of correlation between pixel values. In addition to the plane range, it is considered that the influence of the five central pixels on the edge pixels is greatly reduced, and we can better save the screen pixel values at the edge of the image.

The mathematical formula is as follows:

$$g.x5y4 = \frac{\sum_{k5l} f.k5l4\omega.\mathrm{x5y5k5l4}}{\sum_{k5l} \omega.x5y5k5l4} \cdot 5. \tag{10}$$

The mathematical expression of the domain kernel is

$$d.x5y5k5l4 = \exp\left[-\frac{.x - k4^2 + .yl4^2}{2\sigma_r^2}\right] \cdot 5. \tag{11}$$

In the formula, d is the Gaussian variance.

The mathematical expression of the range kernel is

$$r.x5y5k5l4 = \exp\left[-\frac{\|f.x5y4 - f.k5l4\|^2}{2\sigma_r^2}\right]. \tag{12}$$

The mathematical expression of the bilateral filtering weight function is

$$\omega.x5y5k5l4 = \exp\left[-\frac{.x - k4^2 + .y - l4^2}{2\sigma_d^2} - \frac{\|f.x5y4 - f.k5l4\|^2}{2\sigma_r^2}\right]. \tag{13}$$

2.2.2. Image Equalization Processing. The target image after bilateral filtering will be distorted to a certain extent. We also need to perform histogram equalization processing on it and then nonlinearly change some parts of the target image where the gray values are more aggregated. It should be noted that the order of gray value arrangement of the original image cannot be changed.

The steps of histogram equalization are as follows:

Step 1. Assume that the original image has a total L of gray levels, which are represented by $f_i(i = 0, 1, 2, \cdots, L - 1)$.

Step 2. The number of pixels that meet the conditions is counted, the grayscale is set as n_i, and its mathematical expression is

$$p_f.f_i4 = \frac{n_i}{n} \cdot 5. \tag{14}$$

In the formula, $i = 0, 1, 2, \cdots, L-1$; n is the total number of pixels.

Step 3. Calculate the probability distribution function:

$$C.k4 = \sum_{i=0}^{k} p_f.f_i \cdot 45k = 51, 52, \cdots, 5L-1. \quad (15)$$

Step 4. For the output image, set the gray level to have a level M, $g_j(j = 0, 1, 2, \cdots, M-1)$, and the given g_j mathematical expression is

$$g_j = \text{int}\,[.g_{\max} - g_{\min}4 \cdot C.j4 + g_{\min} + 0.5]. \quad (16)$$

Note: $g_{\max}$ indicates the maximum gray value.

2.2.3. Image Illumination Interference Suppression Processing Method. This method is mainly for the process of backlight recognition, when strong light interferes with the light-taking process of the photosensitive original of the viewfinder. Before processing the target image, the 3D environment contrast of the target image is improved by means of the nonlinear transformation of illumination. Of course, this is not a perfect processing method. A common drawback is that the target image has too dark or too bright areas that cannot be recognized due to changes in lighting conditions.

The quotient image theory is based on the quotient image algorithm and Retinex theory. The target image is connected with the source image through the numerator and denominator relationship. Let the source image be $I(x, y)$ and the target image (quotient image) be $Q(x, y)$. Its mathematical expression is

$$Q.x5y4 = \frac{I.x5y4}{\widetilde{I}.x5y4} \cdot 5. \quad (17)$$

The denominator in the formula concentrates on the original image processed by the smooth feedback circuit, but the filtering effect is more prominent, and the weighted Gaussian resonator is used for anisotropic power amplification to obtain the elastic processing method image.

$$\widehat{I}.x5y4 = F * I.x5y45. \quad (18)$$

In the formula, $(*)$ represents the convolution operation, and F represents the filter. The filter kernel should meet the following requirements:

$$\frac{1}{N}\sum_{\Omega} WC = 15. \quad (19)$$

In the formula, the result of the domain addition is the convolution kernel, N is set as the normalization factor, and then, the value of W is weighted; C is the Gaussian function.

There are two areas: M_1 and M_2 according to its threshold, at the left and right ends of the threshold. For the threshold of the target image, if it is greater than it, assign it to 1; otherwise, assign it to 0; the mathematical expression is as follows:

$$W.i5j4 = \begin{cases} 15, & I.i5j4 \in M_1, \\ 05, & I.i5j4 \in M_2. \end{cases} \quad (20)$$

In this way, the convolution operation can only be performed on the areas with large grayscale changes, thereby reducing the influence of the halo effect in the case of poor lighting conditions.

2.3. Recognition and Extraction of Plastic Art Features. For the plastic parts of the northern nomadic civilization, the recombination of images and videos is one of the three major steps of digital processing, which is to evenly distribute the images into many subdomains with obvious characteristics and large differences, so that the two sides do not overlap. One of the options after processing is to upload it to the database and use cloud computing to perform fast feature point matching, understanding, and other operations.

2.3.1. Image Feature Extraction Overview. The process of image recognition mainly focuses on two steps: one is to extract and select the features of the preprocessed images and the other is to classify the images that have been determined. Among them are mainly feature extraction and selection as well as classifier design and classification decision [20].

After completing the processing of the image, the computer will identify and analyze it and then use feature extraction and feature selection to select or extract from numerous feature sets to form subsets and then use the classifier to classify the obtained subsets.

Step 1. Feature extraction and selection.

What plays a leading role in the success rate of image recognition is the selection of image feature points in the early stage. The process of feature extraction or selection is shown in Figure 4 below. In this process, the first step is to reduce the dimensionality of the image to obtain a subset that can reflect the essence of the data structure, and this subset has a higher recognition rate. After digitizing an image, a large amount of data is generated, and now, it is only necessary to hard code image pixel values in the spatial domain and then compress them in time to reduce the amount of synthetic data. (The algorithm presentation is provided by these sections a–e). The results are critical for subsequent classification.

Step 2. Classifier design and classification decision.

The key to the success or failure of the classifier is that various factors in the current environment, such as pixel mapping, viewing angle, and lighting, can affect the design of the classifier. In addition to the above image factors, there are classification categories, such as the time difference as the classification standard, based on various classification criteria such as user hobbies and crowd categories. The

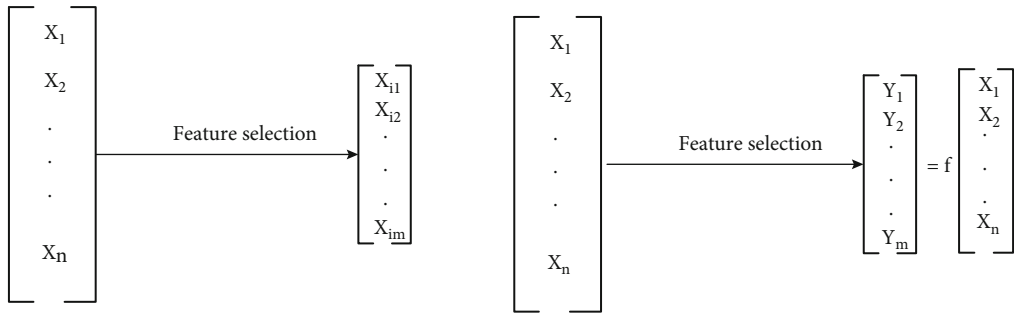

Figure 4: Image feature extraction and selection.

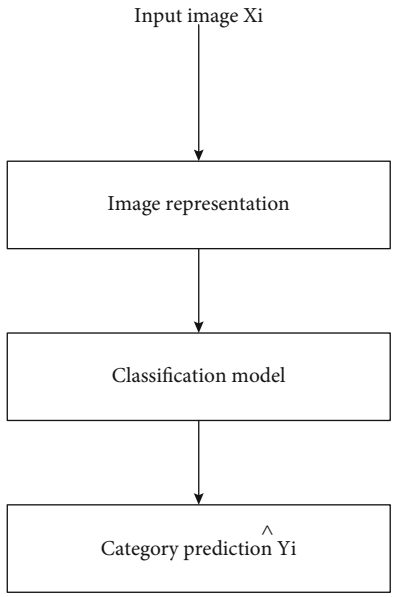

Figure 5: Classifier design and classification decisions.

preprocessed image in the preface is imported into the classifier, and then, its feature points are picked, and then, a classification decision is made, as shown in Figure 5, and it is analyzed, evaluated, and estimated to improve the accuracy as much as possible.

The concept of classification is to learn a classification function or construct a classification model on the basis of existing data. Image classification is generally divided into the following 5 steps: (1) use torchvision to load and normalize the training and test datasets of CIFAR10; (2) define a convolutional neural network; (3) define a loss function; (4) on the training sample data, train the network; (5) test the network on the test sample data.

2.3.2. Support Vector Machine (SVM) Model. SVM is a high-performance and powerful validation set in machine learning, and it is more common in image recognition. The task of SVM is to increase the interval of feature points in the target image to the maximum value, and the calculation is based on the following mathematical expression:

$$\max_{wp} \frac{2}{\|w\|}. \tag{21}$$

Secondly, it will be changed from large to small, and the mathematical expression is

$$\min_{wp} \frac{1}{2}\|w\| f, s.t. y_i\left(w^t x_i + b\right) \geq 1. \tag{22}$$

In the bilateral filtering algorithm, the expression of the definition domain kernel, that is, the d function, selects the weight according to the distance of the image cable. The closer the distance, the greater the weight. This is the same as the box filtering and Gaussian filtering. The r function assigns weights based on pixel differences. If the two pixel values are closer, even if they are far apart, the difference between the pixels and the pixels that are close to each other is greater. It is what the r function does that makes the edges (distance apart) close but different.

In the following mathematical formula, substitute the Lagrangian factor α to get the optimal solution algebraic formula $L(w, b, \alpha)$.

$$L(w, b, \alpha) = \frac{1}{2}\|w\|^2 + \sum_{i=1}^{m} \alpha_i\left(1 - y_i\left(w^t x_i + b\right)\right), \tag{23}$$

where m is the number of samples, and then, the original problem is transformed into

$$\min_{wp} \cdot \max_{\alpha} \cdot L. \tag{24}$$

For the nonunknown partial derivative in the original formula, taking its dual, the mathematical expression is as follows:

$$\max_{\alpha} \sum_{i=1}^{m} \alpha_i - \frac{1}{2}\sum_{i=1}^{m}\sum_{j=1}^{m} \alpha_i \alpha_j y_i y_j x_i^t x_j. \tag{25}$$

Perform a quadratic programming problem through algebraic expressions to solve the optimal value.

One of the tasks of SVM is to convert the collected data samples of the target image from a low dimension to a high dimension through a one-to-one correspondence similar to a function, so as to complete the segmentation of the target image. The value of the variable that realizes the change process and provides high-quality help is called the kernel function, which is the inner product of the corresponding

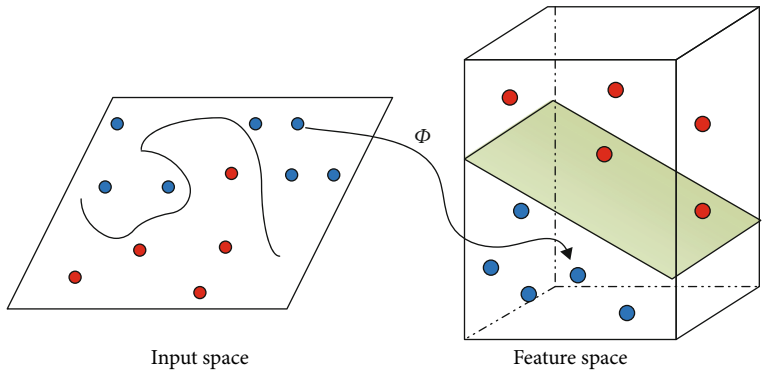

Figure 6: SVM kernel function rendering.

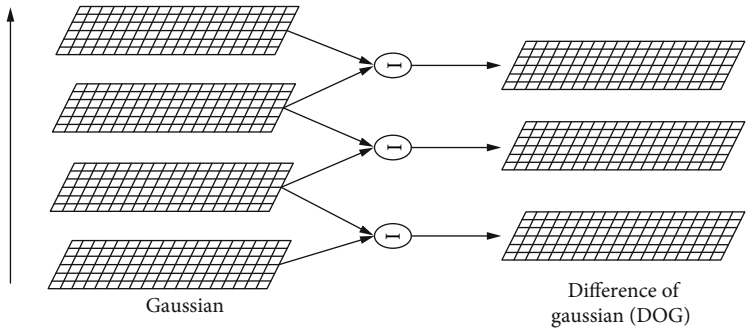

Figure 7: DOG space.

relationship in the Cartesian coordinate system. The so-called function is a mathematical relationship between the two ideal images. Using the relevant nature of the kernel function, a complex kernel function can be constructed and the dimension can be increased. The effect demonstration is shown in Figure 6.

We know that support vector machines can map feature vectors from low-dimensional to high-dimensional, so the kernel function *K of this implementation process* often has nonlinear kernel functions, polynomial kernels, and Gaussian kernels. The calculation formula of each kernel function is listed below:

$$K(x_i, x_j) = x_i^T x_j, \tag{26}$$

$$K(x_i, x_j) = \left(\gamma x_i^T x_j + b\right)^d, \tag{27}$$

$$K(x_i, x_j) = \exp\left(-\gamma \left\| x_i - x_j \right\|^2\right), \tag{28}$$

$$K(x_i, x_j) = \tanh\left(\gamma x_i^T x_j + b\right). \tag{29}$$

This mapping process can be achieved through the above kernel functions.

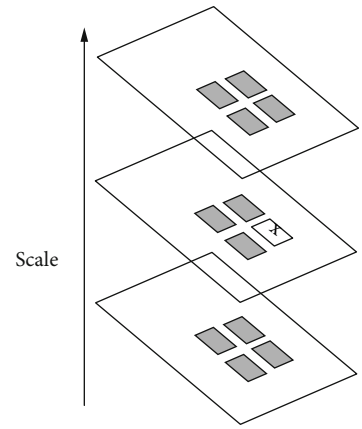

Figure 8: Select the extreme point.

3. Improvement of Feature Algorithm and Neural Network Optimization Function of Deep Learning

3.1. SIFT Feature Algorithm Improvement. For the SIFT feature algorithm, it is divided into four fourth stages: First, in order to consider the extreme point of the specific position in the target image, the Gaussian feature number method is introduced. Second, the image is a rectangular coordinate system of a two-dimensional plane, the specific coordinates of the obtained points in the target image are confirmed, and the low-curvature and low-contrast key points of the edge are removed with the point as a reference. Third, assign

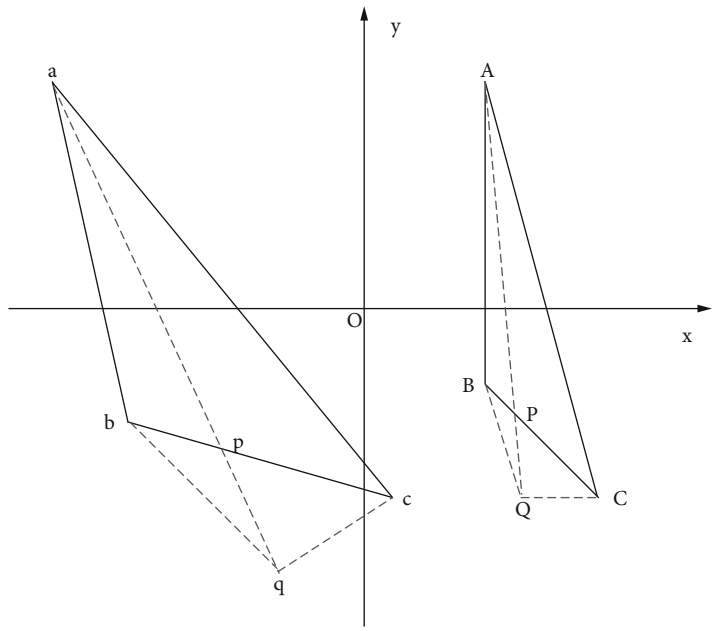

Figure 9: Double position matching criterion.

Table 1: Performance of each algorithm under different noises.

Calculate C	$\sigma = 10$				$\sigma = 20$			
	NMK	NCMK	RCM (%)	T (s)	NMK	NCMK	RCM (%)	T (s)
SIFT	774	560	72.4	10.42	656	408	62.2	9.58
PCA-SIFT	659	501	76.1	8.33	535	349	65.3	6.45
LLE-SIFT	580	488	84.2	5.92	479	353	73.8	4.29

Table 2: Performance of each algorithm under different noises.

Calculate C	$\sigma = 40$				$\sigma = 80$			
	NMK	NCMK	RCM (%)	T (s)	NMK	NCMK	RCM (%)	T (s)
SIFT	545	282	51.9	8.26	179	93	52.3	5.46
PCA-SIFT	379	228	60.3	5.95	147	77	52.9	4.34
LLE-SIFT	223	131	58.9	3.35	164	94	64.5	2.47

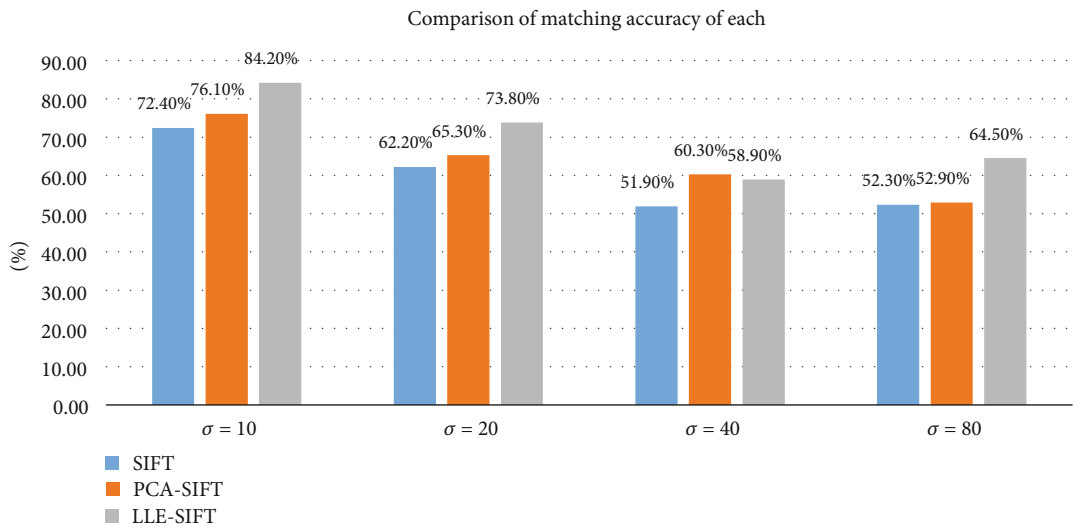

Figure 10: Comparison of matching accuracy of each feature algorithm under different noises.

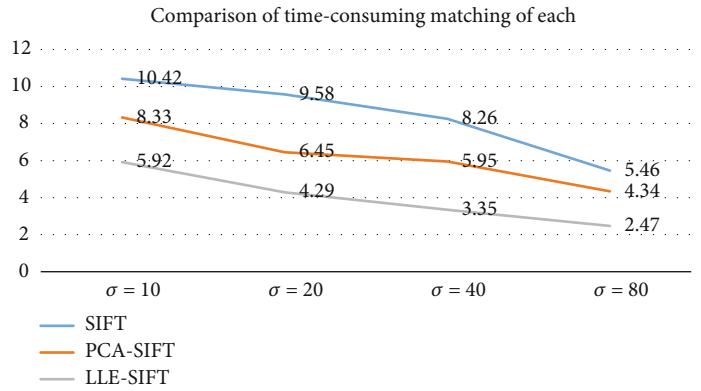

Figure 11: Comparison of time-consuming matching of each feature algorithm under different noises.

Table 3: MAE for different test datasets.

Optimization algorithm	MAE B005 dataset	B006 dataset	B007 dataset
SGD	0.0089_	0.0081_	0.0401_
Adam	0.0033_	0.0011_	0.0817_

Table 4: RMSE of different test datasets.

Optimization algorithm	RMSE B005 dataset	B006 dataset	B007 dataset
SGD	0.0657	0.0619_	0.1274_
Adam	0.0132_	0.0126_	0.0817_

principal directions to vectors of feature points. Fourth, use Euclidean distance to calculate the similarity of feature vectors.

3.1.1. Build an Image Pyramid. The image pyramid is divided into O groups, each group of S layers, and the relationship between the layers is defined as a progressive relationship: the upper layer is sampled from the bottom layer. Each pixel in the DOG is set to be the extreme value in the fixed neighborhood and the N domains corresponding to the upper and lower layers. The feature points of the DOG in the image are shown in Figures 7 and 8 [21].

3.1.2. Double Position Matching Criterion. In order to reduce the error caused by feature extraction under the condition of traditional algorithm, we introduce a double position matching criterion. The specific method is as follows: first, the ratio H of the adjacent image block to the adjacent image block is used as the value of rough matching, and the value of H is set to 1.0. After the rough matching is completed, the image block values are ranked according to the similarity. According to the display of the matching results, decide whether to stay or not for this match. As the corresponding points of sample N with high correlation are used as various standards of this common method, this paper will expound the double matching criterion when mapping 3D to 2D on the 2D level.

In Figure 9, the points that are both (a, b, c) are the reference matching points in the target feature point set and the original feature point set, respectively, and they have a pairwise correspondence. For $\triangle(a, b, c)$ and $\triangle(A, B, C)$, the following mathematical relationship is satisfied between the straight line bc and the straight line BC:

$$\begin{aligned}\left(q_y - a_y\right)x + (a_x - q_x)y + a_y(q_x - a_x) - a_x\left(q_y - a_y\right) = 0,\\ \left(b_y - c_y\right)x + (c_x - b_x)y + c_y(b_x - c_x) - c\left(b_y - c_y\right) = 0.\end{aligned} \tag{30}$$

Order:

$$\begin{aligned}r_1 &= q_y - a_y,\\ s_1 &= a_x - q_x,\\ t_1 &= a_y(q_x - a_x) - a_x\left(q_y - a_y\right),\end{aligned} \tag{31}$$

$$\begin{aligned}r_2 &= b_y - c_y,\\ s_2 &= c_x - b_x,\\ t_2 &= c_y(b_x - c_x) - c_x\left(b_y - c_y\right).\end{aligned} \tag{32}$$

It can be seen from the calculation that the coordinates of the intersection of the two straight lines are

$$\begin{aligned}p_x &= \frac{s_1 t_2 - s_2 t_1}{r_1 s_2 - r_2 s_1},\\ p_y &= \frac{r_2 t_1 - s_1 t_2}{r_1 s_2 - r_2 s_1}.\end{aligned} \tag{33}$$

Since the positions of the points are relative, the following equation holds:

$$\begin{aligned}\frac{|bp|}{|bc|} &= \frac{|BP|}{|BC|},\\ \frac{|ap|}{|aq|} &= \frac{|AP|}{|AQ|}.\end{aligned} \tag{34}$$

According to the position of point Q relative to the triangle (A, B, C), the coordinates of Q *are calculated*, and then,

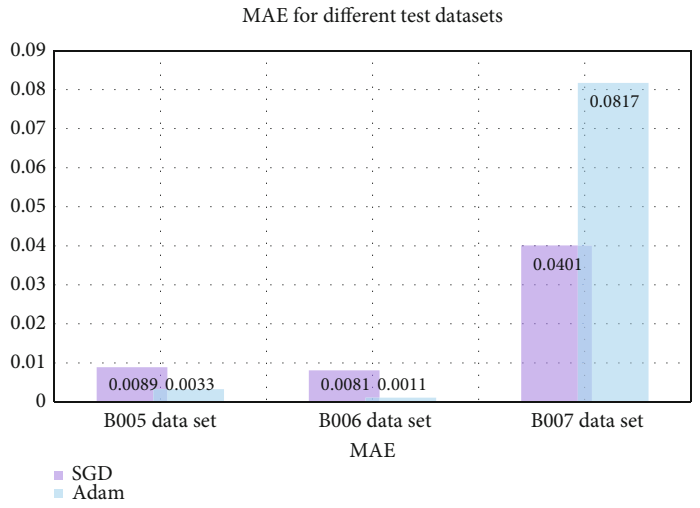

Figure 12: Comparison of MAEs of the two optimizations in different test datasets.

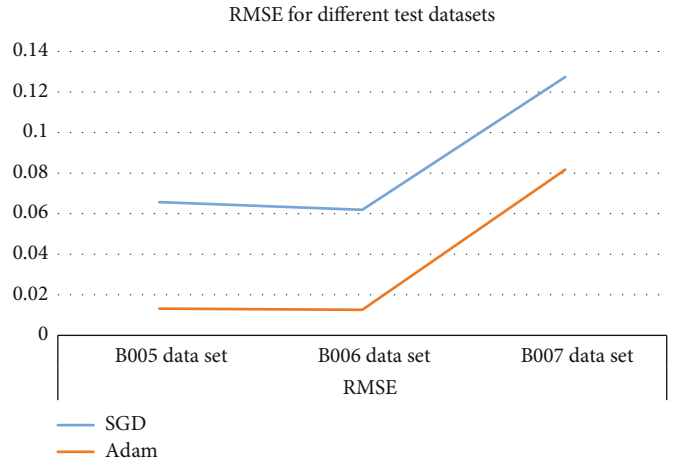

Figure 13: Comparison of RMSEs of the two optimizations in different test datasets.

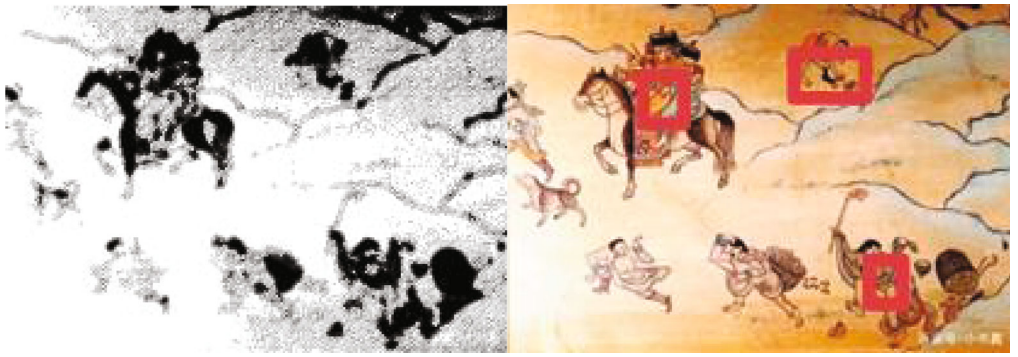

Figure 14: LLE-SIFT algorithm matching.

the coordinate error between δ_1, q, and Q can be obtained [22].

$$\delta_{1,x} = |q_x - Q_x|,$$
$$\delta_{1,y} = \left|q_y - Q_x\right|. \tag{35}$$

If the double coordinate errors of point q are all less than the given threshold, the matching is considered reasonable. The double-matching position criterion can avoid the problem that the points in the image tend to be on a straight line through the traditional algorithm and bring about a large error.

3.2. Adam Optimization Algorithm. In the neural network of deep learning, Adam is a first-order optimization algorithm

Figure 15: LLE-SIFT algorithm matching.

Table 5: Performance of each algorithm under rotation and scale changes.

Calculate C	NMK	NCMK	RCM (%)	T (s)
SIFT	435	351	80.8	7.46
PCA-SIFT	411	325	79.2	5.88
LLE-SIFT	392	360	92.0	3.48

that can solve the stochastic gradient descent problem [23]; instead of the traditional method, it is based on the training data iteratively updating the neural network weights. The algorithm estimates the first and second moments of the gradient of each parameter from the final function [24], and computes it with an exponential moving average. Under the condition that the enlargement and reduction of features remain unchanged, the problem of high noise and gradient dilution in the iterative process is solved, and the formula is expressed as follows:

$$\theta_i^{(k+1)} = \theta_i^{(k)} - g_i^{(k)}, \tag{36}$$

$$g_i^{(k)} = \frac{\eta \widehat{v}_i^{(k)}}{\sqrt{\widehat{s}_i^{(k)} + \varepsilon}}, \tag{37}$$

$$\widehat{v}_i^{(k)} = \frac{v_i^{(k)}}{1 - \beta_1^k}, \tag{38}$$

$$\widehat{s}_i^{(k)} = \frac{s_i^{(k)}}{1 - \beta_2^k}. \tag{39}$$

In the above formula, in the iterative process of the parameter space, k represents the number of iterations, $\theta_i^{(k)}$ represents the first i feature parameter, $g_i^{(k)}$ represents the value of the distance along the gradient descent (k), and $\widehat{s}_i^{(k)}$ and $\widehat{v}_i^{(k)}$ are the bias corrections for the exponentially decaying mean of the power and quadratic historical gradients, respectively [25].

4. Experimental Simulation

In order to ensure the compatibility of the algorithm, a large amount of data is used for experimental verification. The experimental objects are as follows: the number of successful matching points, the matching accuracy rate, and the matching time-consumption. The advantages of the algorithm before and after the improvement are often determined through the above comparison angles. According to the above four considerations, after summarizing, an experimental comparison is made in terms of accuracy and time. Finally, the improved superiority of this paper is compared through the real case of the plastic art feature extraction of the northern nomadic civilization.

4.1. LLE-SIFT Feature Algorithm for Gaussian White Noise Correlation Difference Experimental Simulation. This part of the experiment is mainly to compare the performance of different algorithms under different Gaussian white noise. We explore the comparison of experimental results when σ is 10, 20, 40, and 80. The comparison of the intelligent image recognition algorithms of the terminal is shown in Table 1. From Tables 1 and 2, it can be seen that the more Gaussian white noise, the greater the impact on the algorithm, and the success rates of the three are relatively low, but among the three, LLE-SIFT still maintains a high performance in different Gaussian white noises. The success rate and matching time are also the lowest. The comparison of the three algorithms under the change of noise conditions is shown in Figures 10 and 11 (NMK: matching logarithm; NCMK: matching successful logarithm; RCM: matching correct rate; T: matching time.)

4.2. Experiments on the Performance Comparison of Adam Optimization Algorithm. Based on the introduction of the Adam optimization algorithm proposed in this paper, taking the neural network GUR as an example, the Adam optimization algorithm is evaluated by comparing the mean absolute error and square mean error of the two models SGD-GUR and Adam-GUR in multiple different datasets. The performance of the experimental data is shown in Tables 3 and 4, and the experimental comparison diagrams are shown in Figures 12 and 13.

MAE is the mean absolute error, and RMSE is the root mean square error. From the experimental data obtained in Table 3, it can be seen that the mean absolute errors of the SGD-GUR model in the three datasets are 0.0089, 0.0081, and 0.0401. The average value is 0.0190, while the average absolute variance of the Adam-GUR model in the

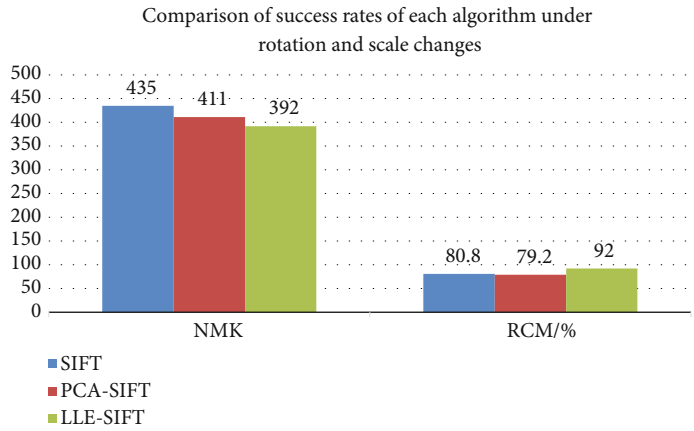

Figure 16: Comparison of matching accuracy of each algorithm under rotation and scale changes.

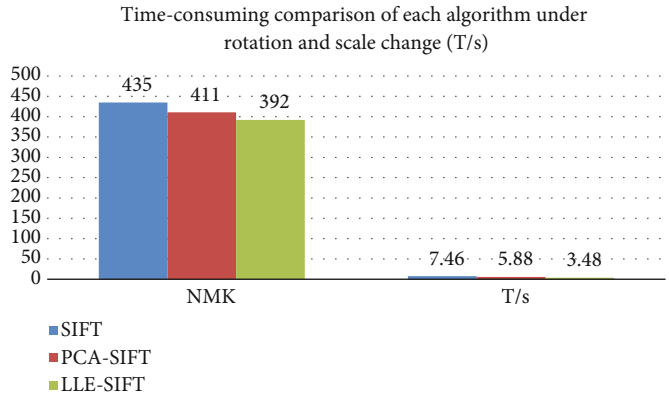

Figure 17: Comparison of the time-consuming matching of each algorithm under rotation and scale changes.

three datasets is 0.0033, 0.0081, and 0.0817; the average value is 0.031; and the experimental data obtained is shown in Table 4. It can be seen that for the SGD-GUR model, the root mean square errors of the three datasets are 0.0657, 0.0619, and 0.1274, with an average of 0.085. The root mean square error of the Adam-GUR model in the three datasets is 0.0132, 0.0126, and 0.0817, and its mean is 0.0358. After the visual presentation of Figures 12 and 13, it can be clearly found that different datasets will affect the training of the model to different degrees. The GUR model using the Adam optimization algorithm solves the problem of accuracy decline and improves the prediction accuracy, making it more stable.

4.3. Examples of Feature Extraction of Plastic Arts of Nomadic Civilization in Northern Grasslands. Select the experimental image and rotate and scale it by a certain degree, as shown in Figures 14 and 15. The feature points are extracted by the LLE-SIFT algorithm, the experimental data table is shown in Table 5, and the experimental comparison diagrams are shown in Figures 16 and 17.

The other two comparison algorithms, SIFT and PCA-SIFT, are compared with the improved algorithm in this paper. From the experimental data obtained in Table 3, it can be seen that the LLE-SIFT feature algorithm performs better than the other two algorithms; the comparison of the three algorithms under different image orientation changes is shown in Figures 16 and 17. Although the image has undergone operations such as rotation, scaling, and excluding the influence of low image edge contrast, the LLE-SIFT feature algorithm can still maintain a high matching success rate.

The purpose of the three comparative experiments in this article is to demonstrate the advantages of the LLE-SIFT algorithm in processing images under the above conditions. It is not difficult to find that among the three algorithms, both the matching accuracy and the time consumption are better than the other two algorithms. In the experiment, we do not have a fixed matching logarithm, which is based on the computing power of the computer and has nothing to do with the pros and cons of the algorithm.

5. Conclusion

Reviewing the foreword, this paper discusses the performance of the plastic arts of the nomadic civilization in the northern grasslands based on the performance of the algorithm level under the deep learning and the test of the simulation experiment, which has shown excellent

performance. It is precisely because the advantages and characteristics of deep learning are applied to the plastic arts, the deep and shallow network is constructed as its input and feature recognition, which solves the problem of image feature recognition. At the same time, the convolution idea is introduced to make its features enlarged, which is more conducive to feature recognition, extraction, and analysis. In the simulation experiments in this paper, the experimental results show that the improved feature algorithm in this paper and the optimization algorithm for deep learning neural network have good performance, but because the hyperbolic tangent or *sigmoid* function used by the model as the activation function will make the neural network, the gradient decay on the network layer makes the model very difficult to build and train. These are issues that we need to pay attention to. On the road of future development, in the case of ensuring the translation effect of the model, nonsaturating activation functions, such as the *ReLU* function, can be used instead of the original ones to prevent the decay of the network architecture, further shorten the training time of the model, and make the model easier to build and train.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

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Retraction

Retracted: Artificial Intelligence-Based Soccer Sports Training Function Extraction: Application of Improved Genetic Algorithm to Soccer Training Path Planning

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] W. Zhang, "Artificial Intelligence-Based Soccer Sports Training Function Extraction: Application of Improved Genetic Algorithm to Soccer Training Path Planning," *Journal of Sensors*, vol. 2022, Article ID 8375916, 11 pages, 2022.

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Research Article

Artificial Intelligence-Based Soccer Sports Training Function Extraction: Application of Improved Genetic Algorithm to Soccer Training Path Planning

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Artificial intelligence has given a new dimension to the sport and mentality of soccer by tracking and planning the path of soccer and analyzing the learning process. Along with the rapid development of artificial intelligence technology, it is also used in sports events. Soccer, the world's number one ball game, has always received worldwide attention. Although soccer is full of realism, it does not mean that its behavior cannot be predicted. By taking advantage of the role of artificial intelligence, model data from training is used to perform a deeper analysis of the correlated role of a soccer team's players in the game, which is very helpful to improve the team's training efficiency and tactics. As an emerging intelligent algorithm, the improved genetic algorithm can seek the global optimal solution based on the results of the algorithm execution and apply it to the planning of soccer training paths, which has a strong application value for improving the team's training level and helping the team to formulate reasonable and effective offensive and defensive strategies. In this paper, we use artificial intelligence as the research background to improve the genetic algorithm by extracting the soccer training function and apply the improved algorithm to the soccer training path planning to get the global optimal solution, so as to help the players find the reasonable and effective optimal path of passing or shooting and help the team to build the tactical planning and winning strategy of offense and defense to meet the earnest expectation of soccer fans.

1. Introduction

With the development of the times and the advancement of technology, modern technologies such as GPS trackers, computer vision algorithms, and sensors are applied to soccer training, and the amount of data contained in the sport of soccer is uncovered. Artificial intelligence has given a new dimension to the sport of soccer and mentality by tracking and planning the path of soccer and analyzing the learning process, that is, in the sport of soccer as a form of psychomotor. For the research experts who apply artificial intelligence to sports training, the soccer institute has given them a sufficiently challenging environment to test their research results. Daley, an internationally renowned soccer coach, has said, "The sport of soccer is not only fun, but contains a relational component of competition and cooperation." The game of soccer contains many possibilities, with unpredictable changes on the field and many uncertainties, and unlike chess and Go, the game is played in a world full of realism, which is a new challenge for the application aspect of artificial intelligence [1].

Although soccer is full of realism, it does not mean that its behavior cannot be predicted. By taking advantage of the role of artificial intelligence, model data from training can be used to provide a deeper analysis of the correlated role of a soccer team's players in the game, which can be very helpful in improving the team's training efficiency and tactics. Through the use of artificial intelligence, the functional features of soccer training can be extracted, and the results can be applied to soccer training planning to extract data for certain specific actions such as passing, shoveling, or shooting to simulate and analyze the size of a player's contribution to a pass or goal. This feature can be applied to post-match analysis to show players what actions to make in

certain situations, such as whether to pass or shoot to help the team score, and can be used to develop training plans based on the intensity of player performance data and health status, track player fatigue, avoid players from being injured during training due to high intensity and overload, and reduce player injury status [2].

For the study of soccer training path planning, we have to mention "gravimetric shadow." The term "gravity" refers to the application of an alternative track to the actual track. As in soccer video games, the trajectory of the soccer ball changes through the use of different joysticks to be used in conjunction with each other, and the coordination of different manipulation controls causes the path distance of the soccer ball to change. This technology can be used to predict and study the chemical effects of tactical changes to control the pace of the game. For example, if a team's star player is injured on the field of play, how the entire team will reformulate its tactics to play the game is something that both coaches and players need to be aware of. Artificial intelligence expert Touhill stated that the purpose of applying artificial intelligence to soccer is not to replace the coach, but to assist the coach's coaching by using intelligent technology to process data that cannot be handled manually, so as to better find solutions to problems [3].

As an emerging intelligent algorithm, the improved genetic algorithm can seek the global optimal solution based on the results of the algorithm execution and apply it to the planning of soccer training paths, which has a strong application value for improving the team's training level and helping the team to develop reasonable and effective offensive and defensive strategies.

2. Research Background

In the 1950s, soccer enthusiast Reippe conducted a study on goal scoring. According to his calculations, most goals were scored by at least four players, and their research created a passing style in soccer. In the past, artificial intelligence has given completely wrong answers in other areas. For example, AI trained in video games has won by breaking the rules of the game and the laws of science. Soccer players trained in soccer data will organize various passing routes for passing attacks based on scientific training path planning and grasp the opportunity to shoot effectively, whether it is a long pass ball or a triangle attack tactic, to carry out a well-traveled, offensive, and defensive battle plan. Artificial intelligence will not replace soccer coaches, but its influence will be more evident in the years to come. The use of AI in soccer training is to form a seamless system that better combines players from all positions on the field through a linkage effect to create the perfect play of offense and defense as one. In the short term, AI may not be able to give full play to its advantages, but in the next 10 or even 5 years, AI technology will be perfectly integrated into soccer training route planning, and some tools will be more mature, even such AI products. With the advent of the "coaching assistant video machine," it is possible to analyze not only pre- and postgame situations but also to view changes in data strategy in the first and second half [4].

Artificial intelligence, as a high-end field, is based on the combination of computer science, statistical science, systems science, and humanities. It is the science of simulating, extending, and propagating human emotions and intelligence [5]. The application areas of artificial intelligence are vast, as shown in Figure 1.

The development potential of the market size of artificial intelligence chips is very huge, and the data in Figure 2 shows that the market size of artificial intelligence chips is expected to exceed $70 billion in 2025. The global artificial intelligence chip market size from 2018 to 2025 and its forecast results are shown in Figure 2.

Corporate investment in the field of artificial intelligence continues to grow, and the industry is gradually maturing, and it can be inferred from Figure 3 that the development of artificial intelligence has strong financial support. Enterprise investment in this field market in recent years is shown in Figure 3.

The research results for artificial intelligence have extended both the function of human brain and the practical labor ability of human. The emergence of artificial intelligence makes the science and technology revolution new life and vitality, opening up the era of intelligence. The introduction of artificial intelligence technology in many fields has also led to new directions and new research points in the industry. Along with the rapid progress of computer technology, the level of artificial intelligence technology has also risen to a new level. Its application to various studies in the field of sports competitions has also become a unique shining point in the field of artificial intelligence. The application of artificial intelligence to sports events can not only enhance the audience's sensory experience of sports events and capture the wonderful moments on the field but also make an objective and fair evaluation of the game process, and to a certain extent, avoid the occurrence of referee disputes between judges and athletes due to unspecified penalties on the field. It also meets the high expectations of coaches, athletes, and sports event staff for artificial intelligence technology and injects new vitality and vigor into various sports events, especially for the world's number one sport, soccer, showing the way for soccer event staff, soccer coaches, players, and soccer fans in general [6].

In soccer, the touchline referee plays an important role in the field rules and in the awarding of the right to validate a goal. However, since the subjective consciousness of the referee can lead to controversies, the referee is equipped with an electronic generator that can detect and check the reasonableness of the referee's penalty in time and then inform the referee of the result. As a kind of electronic timely judgment system in the field of soccer, "soccer electronic referee" can make timely judgment on each goal and whether a player is offside in a soccer match and maintain the fairness of the match. As a product of artificial intelligence, the system components of soccer electronic referee consist of two systems, hardware and software, and are equipped with new high-end technology. The software system includes a variety of advanced software tools, including chips and related software, to rationalize the use of these tools [7]. The hardware system includes a soccer ball positioning transmitter, a

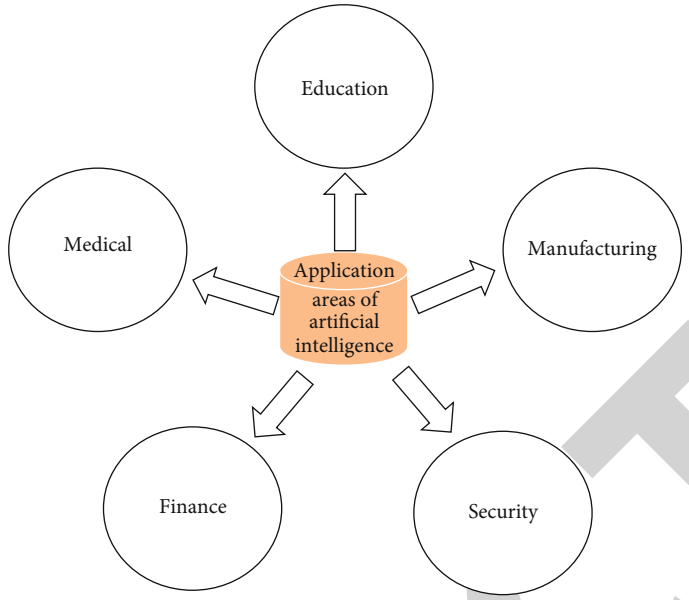

Figure 1: Application areas of artificial intelligence.

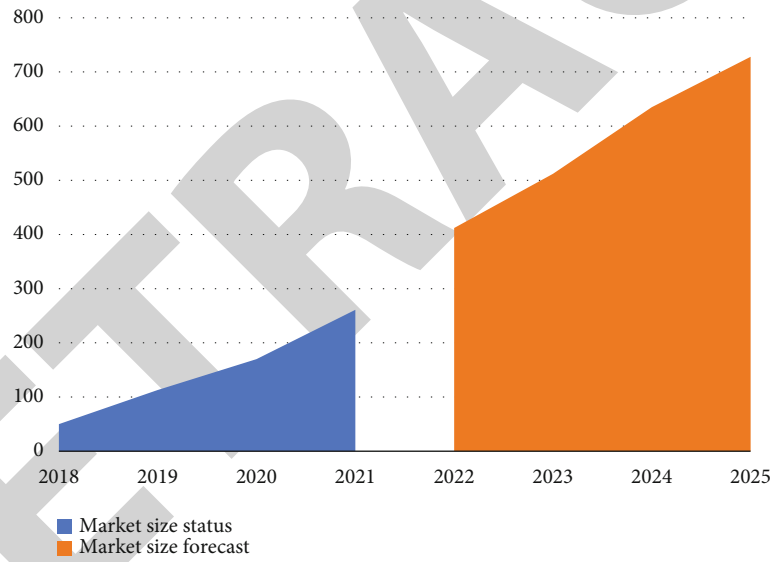

Figure 2: Global artificial intelligence chip market size and its forecast results.

soccer ball path tracker, a ball speed tester, an onside ball positioning transmitter, a player positioning transmitter, and a referee data receiver, and its structure is shown in Figure 4.

The definition of offside position varies in different national and regional soccer leagues. According to FIFA, the decision of an excess penalty is made in conjunction with the pattern of the soccer field to maintain the penalty rules in soccer. Based on the extrapolated pitch feature line, the pitch level is set in the two-dimensional coordinates based on the two-dimensional coordinate model to control the player position and the speed of the soccer ball to achieve a reasonable judgment of the Vietnam soccer game. Among them, the offside detection algorithm set according to the rules of the game is based on the plane coordinates of the players, so to achieve the recovery and interpretation of the plane coordinates of the pitch, only a single camera needs to be selected to shoot the projection matrix to solve the goal. This eliminates many unnecessary processes and complicated computational steps compared to traditional algorithms that use multiple cameras for analysis. After the extraction and interpretation of the video image, a two-dimensional model of the soccer field coordinates can be obtained in binary form using the implementation of an optimization algorithm for stadium detection and extraction. The morphological optimization is based on the 2D image of the soccer field, and then, noise is removed, and data is extracted in open mode [8]. On the basis of area analysis, the nonactive field area is removed, and the two-dimensional image of the playing field area is superimposed

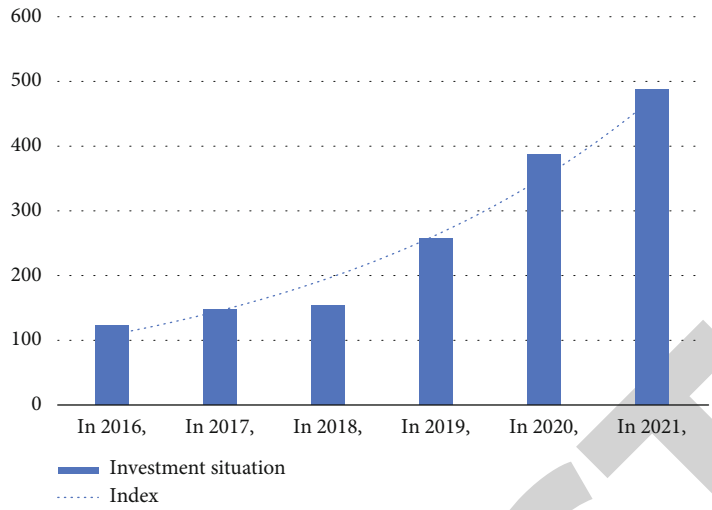

Figure 3: The market enterprise investment in this field in recent years.

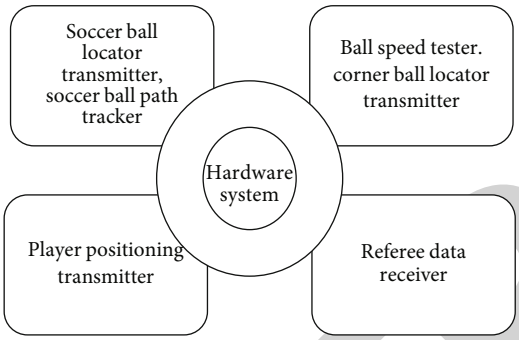

Figure 4: Hardware system structure.

on the original image of the RGB image of the soccer field. After adding the circular image and the double-valued image, the stored templates contained in the master computer and the role of the stadium information construction template are combined with each other to extract and analyze the scenes and offside penalties that appear in the video and to complete the result detection and reasonable and effective analysis performed on the soccer path and the effective data of player attack and defense. After completing the above steps, the entire stadium area is reconstructed in two-dimensional coordinates again, and subsequently, the autonomous discriminatory algorithm of soccer offside is completed with reasonable modifications in order to better detect the offside situations appearing in future soccer matches, reduce the occurrence of controversial scenarios in the stadium caused by penalty errors, and maintain the fairness of soccer matches [9].

3. Research Methods and Materials

3.1. Introduction of Genetic Algorithm

3.1.1. Principle of Genetic Algorithm. The roots of genetic algorithms are among the principles of biogenetics. According to the relevant expertise in the field of biogenetics, species preserve their own traits through DNA during their own evolution and inherit the good traits they contain to the next generation of the species through the genes contained in DNA through biogenetic principles [10]. As early as the 1960s, German university professor Hardman and British geneticist Craig analyzed the complex properties contained in biological evolution. Genetic algorithms have been widely studied since 1967, when a young man named Dirk Berogh formally introduced the concept of "genetic algorithms," and since then, they have been used as an important scientific algorithm in various scientific fields and have achieved a series of fruitful results. Since genetic algorithms are based on the principles of biogenetics, there is no major difference between the principles of genetic algorithms and genetic inheritance. According to the genetic principle of Mendel, the father of biogenetics, the essence of species evolution is the rearrangement of genes and the very low probability of genetic mutation, so that the characteristics of the previous generation will be inherited to the next generation to achieve the continuity of species in the biological world and enhance the excellence of species to enhance the survival ability of species to adapt to the environment. The basic operation of genetic algorithms, as a related principle originated from biogenetics, coincides with the essence of biogenetic species evolution described above. The first step of the genetic algorithm process is the calculation of the fitness value for the initialized population, followed by the determination of whether the fitness satisfies the convergence condition. If the fitness value satisfies the convergence condition, the direct evolutionary process ends; if the fitness value does not satisfy the convergence condition, selected operations are performed on individual adaptive functions, and then, crossover operations are performed based on the probability of change. After performing the selection, crossover, and mutation, the results are transferred to the first step to continue the calculation of the fitness value for the initialized population until the calculated fitness value satisfies the convergence condition; otherwise, the cycle of selection, crossover, and mutation

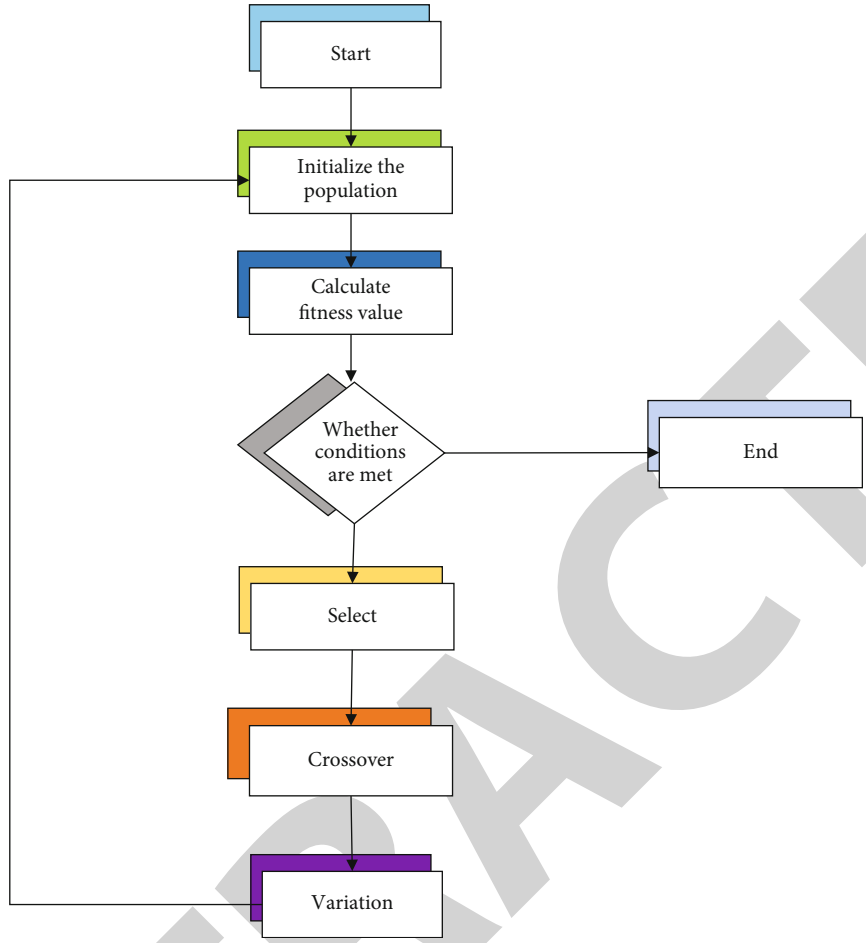

Figure 5: The process of genetic algorithm execution.

steps continues [11]. The process of genetic algorithm execution is shown in Figure 5.

3.1.2. Definition and Basic Theorem of Genetic Algorithm. When using genetic algorithms to plan the path of soccer movement, what steps to go through to ensure that the children obtained after the iterative relationships performed by the control algorithm can maintain a good trend of growth and how to determine the global optimal solution are key issues to be considered when using genetic algorithms for path planning. At this point, it is necessary to mention two fundamental theorems of genetic algorithms: the exponential growth theorem and the average fitness value theorem. To have a deeper understanding and analysis of these two theorems, it is necessary to first clarify the definitions of genetic algorithms [12].

Definition 1. Each genetic operator located in the extended bit-string space, etc., corresponds to the corresponding bit-string space, and the correspondence is in accordance with the basic principles of genetic algorithms. The genetic operator is a specific model for the set of character bit strings, reflecting the fact that the position of the string occurrence in that string set has a considerable correlation with the genetic operator [13].

Definition 2. The number of gene bits in different positions possesses different orders of the pattern, and the number of two identified gene bits in the pattern containing 1 and 2 is defined as the basic order of the pattern, which will be denoted as $D(H)$. During the operation of the genetic algorithm, the increase in the number of iterations executed causes the order of the pattern to change in the same direction as the deterministic come of the pattern. That is, as the number of orders increases, the determinism of the pattern gradually increases. Along with the decrease in the number of orders, the determinacy of the pattern also gradually decreases, and the number of samples will become more and more [14].

Definition 3. The number of bit strings appearing in the pattern can be considered as the dimensionality of the pattern, which will be denoted as $B(H)$. In genetic algorithms, the number of bits appearing in the pattern shows an inverse relationship with the change in the number of samples. That is, as the number of bit strings appearing in the pattern increases, the number of samples gradually decreases; conversely, a decrease in the number of bit strings leads to an increase in the number of sample purposes [15].

Definition 4. The distance between the first definite bit appearing in a pattern and the last definite bit appearing in the pattern can be considered as the order distance of the pattern, which will be denoted as $M(H)$. The order distance represents the length of the defined distance of the pattern and reflects the time difference between the first time identified as an occurrence and the last time identified as an occurrence [16].*(1) Exponential Growth Theorem.* The operation process of the genetic algorithm goes through many steps, and the initial population is subjected to the execution of algorithms such as selection, crossover, and mutation of genetic operators without satisfying the convergence conditions to continue the calculation of fitness values for the initialized population. During the execution of the above algorithm, the patterns whose children contain low order, whose defined length does not meet the standard length, and whose fitness does not reach the average level of fitness of the population will grow at a very high rate in the initial population to achieve the higher order evolution of the patterns, and their growth rate can reach exponential levels, hence the name exponential growth theorem [17].

(2) Average Fitness Value Theorem. During the operation of the genetic algorithm, the patterns in the population that are at the lower order level can be evolved to the higher order after the execution of algorithms such as selection, crossover, and mutation of genetic operators. This is known as the average fitness value theorem. This theorem is more beneficial to obtain the global optimal solution to accomplish the goal of the algorithm while ensuring the normal operation of the algorithm [18].

Using the initial population as a starting point, when applying genetic algorithms to the study of path planning, it is not necessary to solve the set of solutions separately for those sets for which the solution set is already known. These known solutions are used as optimal planning paths in soccer training, and the initial population is constructed by extracting individual known feasible path solutions in the scope of the problem solution space according to the principle of equal extraction. The starting moment is set to t_0, so that $t_0 = 0$, and the number of individuals is represented by n. Then, the n individual changes together constitute the initial population $C(t)$, and usually, the fitness of the individuals contained in the initial population is at a low level, which needs to be improved by the genetic algorithm to simulate the biological evolution process in order to find the final optimal solution more easily to realize the optimal path planning for soccer training, thus improving the team training efficiency and helping to match the team tactical system [19].

3.2. Improved Genetic Algorithm

3.2.1. Optimizing the Parameter Selection Method. The selection of parameters occupies a key position in the genetic algorithm. The choice of different control parameters will affect the convergence effect of the algorithmic process and even the performance of the whole genetic algorithm. There are many parameters embedded in the algorithm, which include selection probability pm, crossover probability pa, variation probability pn, and population size N. The selection of the parameters in the algorithm should be done with the sensitivity of the algorithm process in mind, and the selection of the parameters should be done appropriately without affecting the performance of the algorithm [20].

The variation operator dominates the optimization process and is usually described as an improvement of the genetic algorithm. During the execution of the crossover operator, some genetic genes may not be retained, when the variation operator can replenish and repair the lost genes and also prevent the genetic algorithm from creating distortions during the convergence process. The frequency of mutation operations is controlled by the mutation probability, so that at a high level of mutation probability, although more individuals will be produced to make the population diversity flourish, the higher probability of mutation makes the originally good pattern becomes a poorer performance pattern. In the case where the probability of variation is at a low level, the variation operation is not conducive to the generation of new individuals, and the population diversity cannot be expanded. Although the good model can continue to maintain its performance without being destroyed, the lack of population diversity will affect the acquisition of optimal solutions, thus affecting the rational planning of soccer paths. In the actual situation, it is also easy to see that when the variation probability pn is at a low level, the stability of the solution population is in a standard level state, and when capturing the local extremes, it is difficult to obtain the global optimal solution due to the strict control of the convergence effect, and the assimilation effect of the solution population may be affected, and the diversity of the solution space is in a stable state, which is favorable to the convergence. Therefore, when improving the genetic algorithm, the variational operator pn must be controlled within a reasonable interval to ensure that its convergence is not affected.

The optimization of the crossover operator also plays an irreplaceable role in improving the genetic algorithm. The crossover operator is always controlled by the crossover probability; therefore, the reasonableness of the crossover probability setting directly affects the operation of the crossover operator. If the level of crossover probability is not set reasonably, it will cause the genetic algorithm to run obstructively. The frequency of crossover operations is also controlled by the crossover probability. If the crossover probability is at a high level, the offspring will cross over sufficiently, but this does not mean that the goodness of the population will be improved. On the contrary, the good patterns in the population will be destroyed by the high frequency of crossover operations, resulting in a large generation gap. If the crossover probability is at a low level, the crossover frequency of each generation will be reduced, which will produce a smaller generation gap and thus maintain the continuity of the solution space and facilitate the acquisition of the global optimal solution to a greater extent. However, too low crossover frequency will lead to slow evolution, and even more individuals will be copied directly to the next generation, thus causing evolutionary stagnation. Therefore, when improving the genetic algorithm, it is also

necessary to control the crossover operator pa within a reasonable range to prevent the serious consequences of its being too large or too small.

Although not the main way to generate new individuals, the mutation operation plays a dominant role in the improvement of genetic algorithms, especially for global search ability. Crossover operations, as the main way to generate new individuals, play an irreplaceable role in improving the local search ability of genetic algorithms. In the process of improving the genetic algorithm, the probability of both is controlled within a reasonable range, and the two operators are promoted to be used in conjunction with each other, so as to find a balance between satisfying the global search ability and the local search ability, and to improve the search performance of the genetic algorithm as a whole, and then find the global optimal solution.

3.2.2. Improvement of Algorithm Termination Conditions. As a complex algorithm simulating the genetic performance of biological genes, the genetic algorithm cannot keep the algorithm going indefinitely without the optimal solution being obtained. To ensure the integrity and reliability of the algorithm, it is necessary to set a reasonable indicator for the algorithm so that its execution process terminates within the given indicator. The original criteria for setting the termination condition of the genetic algorithm are not conducive to a virtuous cycle of the algorithm. Therefore, while retaining the goodness of the genetic algorithm termination condition, four termination criteria are introduced: convergence performance metric, iteration count metric, time measure metric, and human expectation metric. The details are shown in Figure 6.

Convergence performance metrics: in the execution of such criteria, a reasonable judgment is made on the magnitude of convergence performance. When the algorithm is executed to the extent that the size of the degree of convergence is at a high level, it means that the algorithm has been executed to a certain extent, when the size of the individual strings in the population is almost the same, and in this case, the result obtained by terminating the algorithm is close to the global optimal solution

Iteration count indicator: the size of the number of iterations of the algorithm affects the efficiency of the algorithm. When the number of iterations performed by the algorithm is at a reasonable number, the accuracy of the algorithm has reached a fairly high level. Continuing to execute iterations not only does not guarantee a higher level of accuracy but also decreases the efficiency of the algorithm, and even the results obtained gradually deviate from the global optimal solution

Time metrics: any algorithm must be completed within a specified time frame; therefore, to ensure the integrity and reliability of the algorithm, it is necessary to set a reasonable time frame for the execution of the algorithm. The time mentioned here refers not only to the length of the computation but also should include the total number of generated individuals and the iteration time

Human expectation indicators: in addition to the above three objective indicators, human subjective indicators

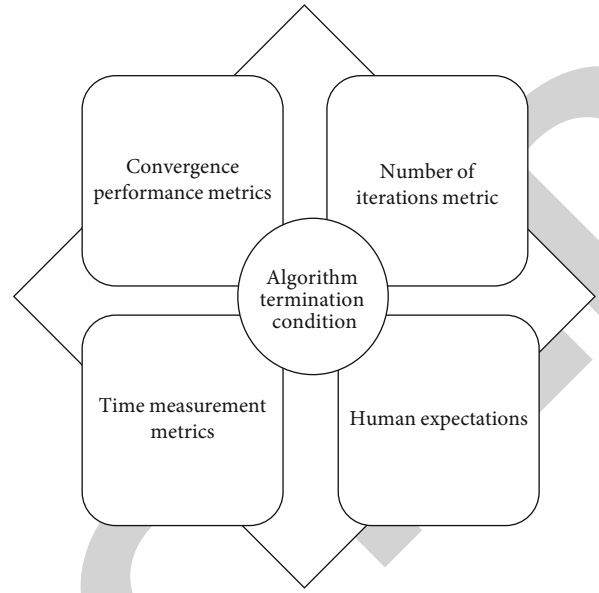

Figure 6: Algorithm termination conditions.

should also be set according to the specific situation. When the execution level of the algorithm reaches the mental expectation standard, the algorithm can be flexibly selected to terminate the algorithm, which not only saves the unnecessary amount of data operations but also saves the computing time and improves the computing efficiency

4. Results and Discussion

4.1. Evaluation of Improved Genetic Algorithm Applied to Soccer Training Path Planning. For example, as a global search algorithm, the genetic algorithm can simplify the analysis of some complex problems that occur in the actual situation, and through the reasonable execution of the number of iterations of the algorithm, the degree of convergence of the system is controlled within a reasonable range, so as to seek the global optimal solution to get the best path for soccer training and to indicate the direction for future team training. The algorithm can be used to find the optimal path for future team training. However, the genetic algorithm does have many shortcomings, for example, the problem of population size setting. If the population size is set too large, it will increase the amount of data computation, thus increasing the global search time and reducing the search efficiency. If the population size is set too small, although it can improve the convergence speed, it may cause the results to gradually deviate from the global optimal solution. In addition, the reasonableness of the coding settings and the design of the genetic operator affect the evolutionary effect and the search ability. If there are poor coding and genetic operator design problems, it will lead to insignificant evolutionary effects, which will affect the global search ability. The genetic algorithm will be prone to errors in manual operation, and unreasonable termination criteria will affect the normal evolution of the population and reduce the degree of excellence of the genetic algorithm. And there are many changes in soccer training paths, which have high

requirements on the accuracy of the genetic algorithm and require the genetic algorithm to play its excellent performance to get the best soccer training path.

In the evaluation of the improved genetic algorithm, there are two indicators for evaluating the performance of the algorithm: the adaptation performance indicator and the average accumulation of performance indicator.

4.1.1. Adaptability Performance Index. The fitness performance metric is the average value of fitness developed from the first generation to the current generation during the operation of the genetic algorithm. Noting the fitness performance index as $Z_e(x)$, $Z_e(x)$ can be expressed as

$$Z_e(x) = \frac{1}{T}\sum_{i}^{T} F_e(t). \tag{1}$$

In Equation (1), $Z_e(x)$ represents the fitness performance of strategy x under background e, where $F_e(t)$ denotes the average fitness function value at moment t or generation t in the population and $fe(t)$ is the result of $F_e(t)$ after conducting the derivation.

4.1.2. Performance Average Accumulation Index. Performance average accumulation index refers to the average of performance accumulation during the operation of the genetic algorithm when it is in the best performance. The performance average accumulation index can be written as $L_e(x)$, and its function value can be expressed in

$$L_e(x) = \frac{1}{T}\sum_{1}^{T} fe(t). \tag{2}$$

In Equation (2), $L_e(x)$ represents the average performance of strategy x under background e, where T denotes the iteration period and $fe(t)$ is the result of $F_e(t)$ after performing derivation.

After the above analysis, it can be concluded that the fitness performance index reflects the overall dynamic evolution of the average fitness of the population during the genetic process of the genetic algorithm in future generations. The performance average accumulation index reflects the overall best performance of the cumulative change process in the process of genetic algorithm, which reflects the characteristics of genetic algorithm with strong convergence.

In the process of executing genetic algorithm using genetic operators, there will be a large number of parent individuals and a series of offspring individuals, and how to judge the relationship between these individuals is a problem that must be considered in executing genetic algorithm, which involves the value of the correlation coefficient of genetic operators. In the operation of genetic operators, the correlation function values are obtained by simulating the evolution of the genetic operator on one or more parents. As with biogenetic principles, there are many connections between the two, and they are strongly correlated. This correlation can be expressed by the correlation coefficient, as shown in

$$P(S_{F,}S_Z) = \frac{\mathrm{Cov}(S_{F,}S_Z)}{\sigma(S_F)\sigma(S_z)}. \tag{3}$$

In the above equation, S_Z represents the average condition of the offspring. $\mathrm{COV}(S_F, S_Z)$ represents the covariance, and ß(S_F) represents the standard deviation of the condition under random conditions. The ability of a new individual to approach a random search depends on the absolute value of the correlation coefficient. If the correlation coefficient of the operator is more absolute, then the ability to generate new individuals will gradually deviate from the random search. If the absolute value of the correlation coefficient is higher, then the ability of the genetic operator to create new individuals will be higher. Therefore, the correlation factor can be used to evaluate the searchability of the genetic operator.

4.2. Soccer Training Path Planning Based on Improved Genetic Algorithm. The first step to consider when planning a soccer training path is to encode the parameters of the problem. The field of play is constructed as a two-dimensional planar coordinate map, and the positions of the players and the soccer ball as well as the goal frame can be measured in terms of coordinates. The center point of the pitch where the ball is kicked off is the origin of the coordinates. All paths from the starting point to the goal point can be represented as vectors, so that not only the size of the path distance can be observed but also its direction and location characteristics can be determined. A reasonable path is not the shorter the better, but its effectiveness in passing or shooting should be considered. The optimal paths under various tactical systems can be obtained by the operation of genetic algorithms.

As can be understood in the section of the article on materials and methods, when using genetic algorithms for path planning, it is possible to find the optimal path for soccer training, although it is likely to use iterative genetics and the operation of genetic operators to obtain the global optimal solution. However, for a realistic sport like soccer, which is full of various possibilities, the playing field confrontation environment can change drastically at any time and is full of various unknown possibilities. The genetic algorithm needs to refine a large amount of data in order to maximize its performance, which requires a certain amount of time and obviously cannot meet the real-time needs of soccer. Based on the all-round analysis of the pitch environment, it can be understood that the positions between opponents and teammates change in real time and are unpredictable when both teams play against each other. Passes between teammates may be intercepted by opposing players who suddenly appear. In such a case, an improved genetic algorithm is applied to select the optimal path to avoid interception by opposing players when the team players pass the ball. And a simple data calculation is performed to find the global optimal solution, that is, to find the optimal path for soccer training. The improved genetic algorithm can greatly improve the efficiency of selecting

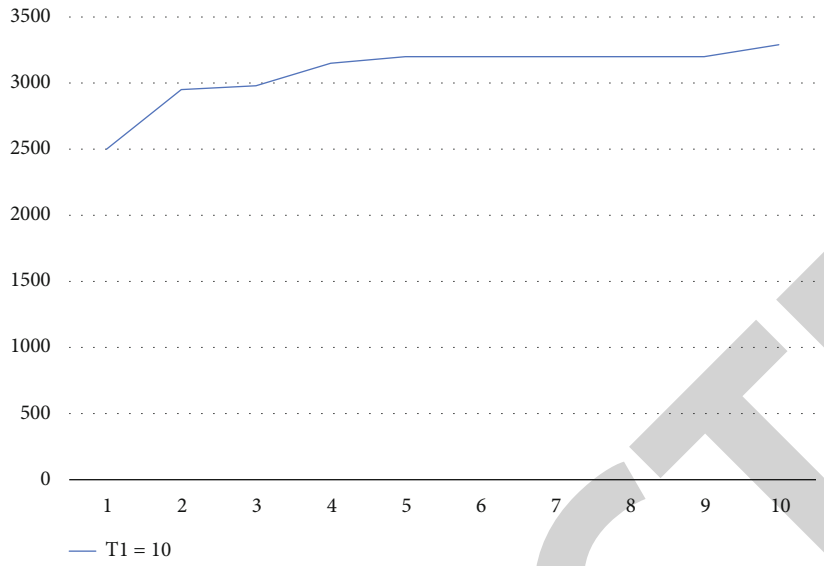

Figure 7: Simulation results of genetic algorithm when $T1 = 10$.

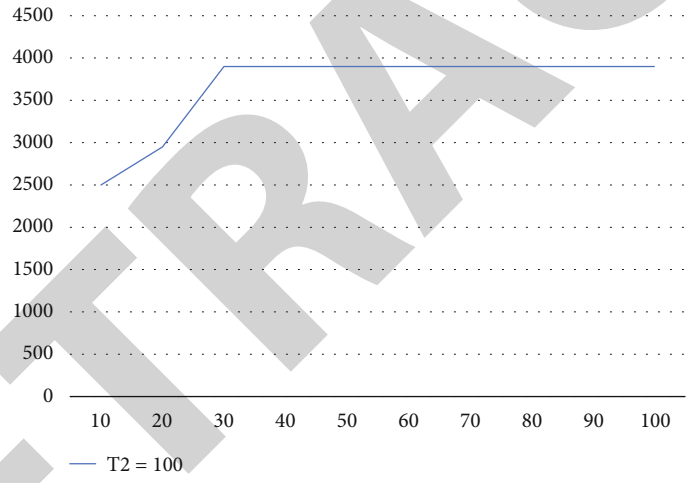

Figure 8: Genetic algorithm simulation results when $T2 = 100$.

the optimal path compared to the original genetic algorithm. Therefore, it is especially important to summarize, classify, and discuss the various contingencies that occur on the field of play. When the field is in a relaxed and simple environment, the control method of fuzzy logic can be used to find the best trajectory of soccer; when the field is in a complex and changing environment, the superiority of genetic algorithm can be used for path planning to find the best trajectory of soccer and help the team to develop a reasonable training strategy.

4.3. Genetic Algorithm Simulation Result Analysis. From the above material, it can be seen that there are different methods in selecting the optimal path for soccer trajectory in different stadium environments, which can save time, improve efficiency, and enhance the players' resilience. Simulation training using the genetic algorithm requires initialization and assignment of many parameters that appear in the genetic algorithm. Two of the more frequently used parameters in this context are the simulation algebra and the initial population benefit, both of which affect the algorithm execution time and the algorithm results. Before the algorithm is simulated, the relevant parameters need to be prepared for assignment. The value of simulation population size N is set to 100, and the length of parameter string L is set to 20; when the simulation algebra $T1 = 10$, the simulation results are shown in Figure 7. With the simulation population size and parameter string length unchanged, when the simulation algebra $T2 = 100$, the simulation results are shown in Figure 8.

Comparing the above two simulation results, it is easy to find that the change of simulation algebra will affect the

genetic algorithm when the simulation population size and string length are constant. When the value of simulation generation is small, such as $T1 = 10$, the genetic algorithm will be transient and stable within a certain range, but the solution appears only as a local optimal solution, and the global optimal solution cannot be obtained. When the value of the simulation algebra is set to a large value, such as $T2 = 100$, the genetic algorithm will run in advance of the optimal solution, so the high setting of the simulation algebra will waste memory space and a lot of data operations, which consumes time and energy. Therefore, it can be concluded that the setting of simulation algebra should be controlled within a reasonable range, and the adverse effects of too high or too low algebra on the algorithm should be avoided. In addition, the setting of the initialization size of the population also appears to be very important; when the size is too small and the known solutions are too few, even if the algorithm can roughly calculate the final result, the output result is not the global optimal solution. The improved genetic algorithm is faster than the traditional genetic algorithm when the course is in a simple and relaxed environment, reducing the amount of data operations and computing time and improving the timeliness of the system. Through the above method, the flexible algorithm operation according to the field environment can plan the path of soccer reasonably and seek the global optimal solution to help the team to build the tactical planning and winning strategy of offense and defense.

5. Conclusion

This paper takes soccer, the world's number one soccer sport, as the entry point and artificial intelligence as the research background, to improve the genetic algorithm by extracting soccer training functions and applying the improved algorithm to the planning of soccer training paths to help players find reasonable and effective optimal paths for passing or shooting.

This paper first introduces the superiority and development status of artificial intelligence in the introduction and research background section and proposes to apply artificial intelligence technology to the research of soccer training path planning, which makes the research content of this paper have some realistic basis. Then, in Research Methods and Materials, the principles and definitions of genetic algorithms and the basic theorems are introduced, and improvements in the selection of optimization parameters and algorithm termination conditions are made to create an efficient new genetic algorithm to find the global optimal solution. In Results and Discussion of the paper, the application of the improved genetic algorithm in soccer training programs is first evaluated; then, the results of the application of the improved genetic algorithm are analyzed, and finally, the simulation results of the genetic algorithm are given. It is shown that the genetic improved algorithm is able to plan the path of soccer movement reasonably according to the flexibility of the playing field environment. In view of the limitation of research time and personal ability, there are still some incompleteness in this paper. There are still many problems to be further explored and discovered for the optimal path planning of soccer training by the improved genetic algorithm.

Data Availability

The dataset is available upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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Retraction

Retracted: Research on the Use of Task-Based Language Teaching Method in English Language Teaching Based on Big Data 5G IoT Scenario

Journal of Sensors

Received 23 January 2024; Accepted 23 January 2024; Published 24 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] C. Xu, "Research on the Use of Task-Based Language Teaching Method in English Language Teaching Based on Big Data 5G IoT Scenario," *Journal of Sensors*, vol. 2022, Article ID 4926105, 11 pages, 2022.

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https://doi.org/10.1155/2022/4926105

Research Article

Research on the Use of Task-Based Language Teaching Method in English Language Teaching Based on Big Data 5G IoT Scenario

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The state implemented the compulsory education standard for full-time students in 2001, which clearly stipulates that English teachers should promote special language teaching methods, develop comprehensive language use skills, and propose teaching methods such as practice, cooperation, and communication. The task-based language teaching method has become a commonly used method in English teaching, and it is necessary to study the application of task-based language teaching method in English courses and try to apply the task-based language teaching method effectively. This study analyzes the needs of English teaching in the context of big data 5G IoT scenario, new curriculum reform, and theories related to English teaching methods in order to explore new methods of English teaching, verify its feasibility and necessity, and prepare reference materials for future grammar teaching research.

1. Introduction

In the 4G era, the rapid spread of mobile Internet; the popularity of social media such as Facebook, Twitter, and WeChat; and the use of traditional electronic messaging and interactive meetings have changed the content and form of information transfer and sharing. The impact of the upcoming 5G era will be even more evident with the emergence of new applications or software with high transmission speeds and depth of artificial intelligence, which will enable more diverse communication and technological advances that are changing the way people learn English [1]. In the 4G era, various terminal English teaching programs or applications have had an impact on English teaching. With the advent of the 5G century, smarter and deeper "Internet+" ELT software, hardware, or applications, such as smart English textbooks and smart English pencils, will further drive explosive growth. Instead of going down the same old road, classroom English teaching should actively learn new technological achievements and apply them to all aspects of classroom English teaching. In other words, the use of new achievements in technology, especially in the 4G and 5G era, is not only a turning point but also a necessary means to advance the reform of the university English curriculum, whether from line to line or from the combination of cloud computing, big data, artificial intelligence, virtual reality, and education to be more intelligent. In September 2018, the National Development and Reform Commission issued the "Guidance on Developing a Stable Digital Economy and Expanding Employment," proposing innovative talent cultivation models and vigorously developing "Internet+," mobile technology, and Internet technology. We actively use practical and other digital teaching and training means and promote the introduction of new teaching methods such as microteaching, live under hybrid teaching, and webcasting, so that the general public can widely participate. With the rapid development of technology, there is a trend of integration between the education and information technology communities. The use of cloud computing, artificial intelligence, 5G, and other mobile communication technologies has made English teaching smarter to design English courses, and the National Development and Reform Commission guidelines on building a stable digital economy and increasing employment state that artificial intelligence and mobile communication technologies should be incorporated into the training and certification processes. According

to the need for specialization, English language instruction, the use of human-computer interaction, artificial intelligence and 5G mobile communication, digital teaching resources, the creation of a good English language learning environment for students, and the necessary material conditions for modernization [2] were needed.

This is how the task-based language teaching method has been developed. According to the requirements of the new curriculum of 2001, teaching English skills should include pronunciation, vocabulary, grammar, functions, and themes. In addition, the new teaching standards clearly state that reform is not only a renewal of the content of knowledge but also a renewal of the forms of knowledge transmission. Therefore, English teachers have the responsibility to change their concepts and outdated teaching methods and forms of teaching. English learners in the new era should have systematic language skills and be flexible in using the language skills they have learned. From this perspective, the new curriculum reform requires English teaching, especially grammar teaching, to reach a higher level [3]. Theoretically, special teaching methods adapted to the needs of English language teaching and social development have been widely used in China. In 2001, the new English curriculum developed a task-based language teaching method to improve the overall language skills of students. The application of the task-based language teaching method in language teaching places stringent demands on English teachers, but many teachers of English courses are unable to plan and control their classrooms under the guidance of the teaching method. This study analyzes the needs of English teaching in the context of big data 5G IoT scenario, new curriculum reform, and theories related to English teaching methods in order to explore new methods of English teaching, verify their feasibility and necessity, and prepare reference materials for future grammar teaching research. Teachers still occupy a central position in the English classroom, especially in reading classes. Teachers often provide students with reading materials to help them understand vocabulary, sentence patterns, and grammar rules. In other words, there is too much emphasis on language and grammar explanations. Students rarely have the opportunity to express themselves during the learning process, and they are left to passively receive knowledge. This model of teaching is known as the traditional teacher-centered teaching model. Students should not passively absorb knowledge in reading classes, but actively participate in interactive activities. The traditional teaching method runs counter to the basic goals of foreign language teaching. The main elements of the task-based language teaching method are that language is a valuable tool for social expression of ideas and communication and that the function of language and the purpose of communication can also be expressed through the structure of language [4]. Therefore the study of the use of task-based language teaching method in English language teaching has the following requirements and roles.

First, the trend of changing language perspectives is at the heart of curriculum reform.

Second, teachers should pay more attention to teaching reading methods and reading skills.

Thirdly, it is emphasized that classroom instruction should match the age, knowledge level, and interests of students. Finally, an active learning model based on experience, practice, participation, communication, and tasks is proposed to develop students' language integration skills. ELT emphasizes that students should be guided by their teachers to complete tasks in their daily learning in order to build self-confidence and develop their overall language skills.

2. Research Background

Foreign researchers point out that in the late 1970s, the linguist Prabhu first proposed the task-based language teaching method which was the beginning of the research on task-based language teaching method [5]. In the 1980s, the task-based language teaching method gradually developed and a large number of foreign language teaching researchers generally adopted the task-based teaching method. Many international scholars, such as Breen, Willis, Noonan, and Ellis, have published scholarly works on task-based language teaching methods. According to the English Language Learning Standards, the classroom is used as the foundation for all help students practice and learn using the English language. Students should first and foremost act as users of the language, paying special attention to the transfer of information in the learning process. English teachers must develop tasks based on a thorough understanding of the learning objectives, students' levels and interests, and life experiences, with the goal of not only developing students' language skills but also improving them. Anh and Koen defines tasks as rewarding or voluntary or purposeful activities [6]. Richard defines the activities that people do after learning and understanding the language, and Breen concludes that the task is a series of learning activities carefully designed by the teacher before the lesson, providing opportunities to improve knowledge and skills through the adoption of new language. Noonan sees communicative tasks as an occupation related to how students understand and use the language of instruction in communicative situations. According to Scahan, all task-based language teaching is operational and important for performing these tasks, and performing task activities must be connected to real life. In addition, tasks are evaluated on the basis of their successful completion and the definition of the task as "the way in which the work plan requires students to learn the language in order to obtain assessable results upon submission of correct or appropriate proposals" [7]. Jose stated that "a task is a separate hierarchical group in which students must solve a problem through communication and cognitive processes. There are specific purposes and goals." He conducted a study combining special conditions instruction with computer-assisted instruction in a Spanish research institute, and the results showed that the combination of synchronous electronic conversations and web-based homework language instruction had a significant impact on English self-learning [8]. Since the 1980s, researchers have considered task-based language teaching methods as an effective means of improving communicative competence in language teaching. The task-based approach is a task-based approach to language

teaching through the organization of the teaching process in secondary schools. Teachers perform tasks using different forms of instruction, such as participation, experience, interaction, communication, and cooperation. It fully develops students' cognitive abilities and stimulates the use of the existing target language. The focus of training is on tasks, which provide learning activities that go beyond mechanical language practice. The task-based approach increases students' interest and efficiency in learning within a limited time frame. In order to complete the task, students must use their abilities to participate in the activity [9].

The status of domestic research, since the 1990s, scholars such as Wu Xudong and Shatime introduced the syllabus of task-based language teaching method in China, which has attracted great attention from foreign language teachers in universities. Shame was the first scientist to study language learning in tasks, and as a first step, she proposed an English teaching method within the remit that English teaching must be closely linked to the real world and classroom teaching must be closely linked to society. The purpose of language teaching is not only to learn the language but also to improve students' awareness [10]. The use of pure English knowledge and other teaching methods in the classroom should be avoided as much as possible, and diverse teaching methods should be provided. From the point of view of applied teaching, English language teaching should contribute to the improvement of students' language literacy. Teachers should design and implement targeted and diverse internal and external teaching activities according to the teaching objectives and the students' actual situation. The conclusions drawn from these two paragraphs fully reflect the content of the task-based language teaching approach. As a result, they have furthered the research of Chinese scholars and teachers on the form of task-based language teaching method [11]. In addition to this form of teaching and learning, the development of task-based language in China has been driven by the preparation of various research papers and by foreign language teachers and researchers in Chinese universities. Research on task language learning by local scholars has been presented from different perspectives. Yuan Changhuan, Cheng Kra, and Xu Xiaoqing argue that task-based language teaching incorporates theories related to second language acquisition. Gong Yafu and Luo Shaoqian argue that this theory comes from language acquisition theory, social constructivist theory, and curriculum theory. Cheng Xiaotang proposed the theory of communicative teaching and second language acquisition theory contributed to the formation of this theory part of the theory has been studied by several scholars in China in terms of task classification; some scholars believe that there are some special and general tasks and that most interactive tasks used in the classroom are practical and learning tasks, so task division is not absolute, and in 2001, task teaching made significant progress. China, the country with the largest number of English language learners in the world, has developed English curriculum standards that focus on learning tasks and promote targeted instruction, attracting a large number of monographs and papers on thematic teaching and learning [12].

3. Research Methods and Materials

3.1. Internet of Things

(1) Concept

There is no mandatory definition of the Internet of Things. IoT alias intranet, technically speaking, IoT is the integration of sensors, wireless sensors, intelligence, internet, RFID, intelligence, nanotechnology, etc. Through IoT, everything can be connected and it also features control, accurate and reliable intelligence transmission and processing, sensing, integration, etc. [13].

The concept of IoT was first introduced by the Automatic Identification Laboratory at MIT in 1999. It states that sensors and information devices will be connected to the Internet through information such as RFID, which is not only intelligent. It also allows automatic identification and management of network properties. Wireless transmission, sensor networks, networking technologies, and RFID methods are the core and technologies [14].

With the development of wireless sensors (WSN), radio-frequency identification (RFID) networks and related technologies such as nanotechnology and intelligent integration, the report concludes that with the Internet, the world will be able to connect and humanity will enter the era of networked interconnection. Generally speaking, the intranet consists of five components, namely, readers, electronic tags, analysis servers with network names, intranet intermediate nodes, and intranet dissemination services. In this system, the only code is kept in the electronic tag [15]. The RFID code contains information elements including product name, production time, shelf life, and type. The workflow is to read the identifier, read the information stored in the electronic tab, send the middleware, send the command, send the name, send the name of the analysis server, request the item, address of the minimal device, and the identifier passes the details of the request through the corresponding address under the name. After receiving the request from the master, the server passes the details of the element to the intermediate server to obtain specific information about the element in question [16]. Figure 1 shows a typical IoT architecture.

(2) IoT hierarchy

Currently, communication networks are at the forefront of technology and the technology is complex. Based on the analysis of the existing network IT technology application requirements, it is divided into three levels: perception level, network level, and application level [17], as shown in Figure 2.

3.2. Task-Based Language Teaching Method

(1) Concept

In general, the aim of task-based language teaching method is to make language teaching more realistic and social. The so-called authorized language teaching method in the traditional sense takes the completion of communicative tasks as the main purpose of foreign language teaching. The goal is

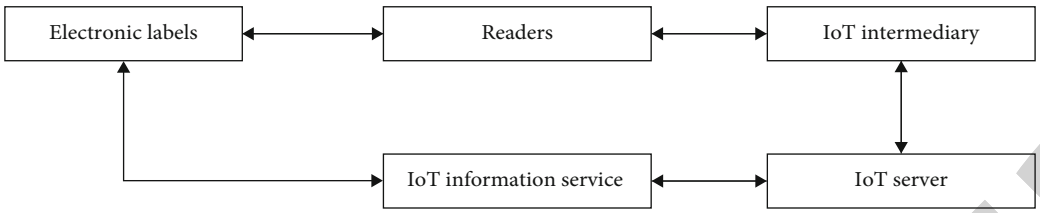

Figure 1: Typical IoT structure.

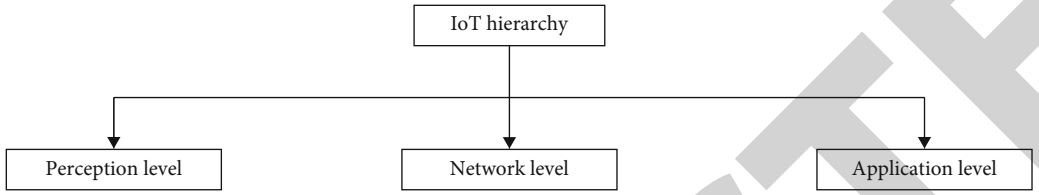

Figure 2: IoT hierarchy division.

to develop communication-oriented activities in practical training. With the help of cooperative learning groups for task-based learning, students realize that learning here is not about using textbooks and repetitive supplementary exercises, but about practice and language application. In the English classroom, the task is to closely integrate the goals of language teaching and learning with the goal of improving work skills by organizing a series of learning activities that maintain a deep connection with the outside world, instill cognitive skills in students, and effectively improve communication skills. In teaching practice, on the one hand, students should acquire knowledge from teachers, and on the other hand, students should receive education. Therefore, teachers must change the traditional way of teaching English and create a good teaching, entertainment, and English teaching environment to mobilize students in the process of teaching English. To make English lessons more effective, teachers must have a deeper understanding of students' personalities and needs, enhance emotional and intellectual communication among students, develop positive attitudes toward learning, and promote their overall development [18].

(2) Principles

The following summarizes the seven basic principles of the task-based language teaching method, as shown in Figure 3.

Foundation on the curriculum and materials: i.e., the curriculum and materials should serve as the basis for early learning in the learning process, and students should not expect the learning process to proceed without explicit or implicit language representations.

Task-dependent: in this category, new tasks are not added but are determined by previous tasks.

Recycling: restoring opportunities for language learning, expanding the scope of learning as much as possible, activating the principle of "organic" learning.

Active learning: acquisition of practical skills. The most effective way to improve the quality of teaching is to keep the learner learning the language.

Integration: the way students are taught should make clear the link between the teacher's dominant style and the students' creativity.

From reproduction to creativity: students should be encouraged to move from reproducible language to creative language.

Reflection: students should have the opportunity to reflect on what they have learned and how they have done it. These principles are important for the study of English teaching methods.

(3) Areas of teaching practice

A distinctive feature of task-based language teaching is the task and its practice. Instructional practices are reflected in the following areas.

Task language instruction provides students with a set of communicative tasks that they must complete in the target language. Students can learn the language while completing the tasks. Following the concept of task language teaching, language projects are transformed into various tasks through the development of curricula and materials. Exposure, perception, experience, and use of language procedures to accomplish these tasks.

Task-based language teaching emphasizes the importance of student expression in the classroom. This refers to the transmission of information, opinions, and views. In particular, students usually talk about information or suggestions that they know in advance. The focus is on the student rather than the teacher. While teachers play an equally important role in teaching the languages they work in, teaching the languages they work in emphasizes that teaching must be student-centered and that the teacher is not in charge of the class. In teaching the language of instruction, the teacher's primary task is to develop appropriate tasks or to provide students with the necessary materials to perform the activities that require them to complete the tasks. Students usually work individually or in groups to complete the tasks.

Students are encouraged to use their language skills creatively. Students have more freedom of expression when

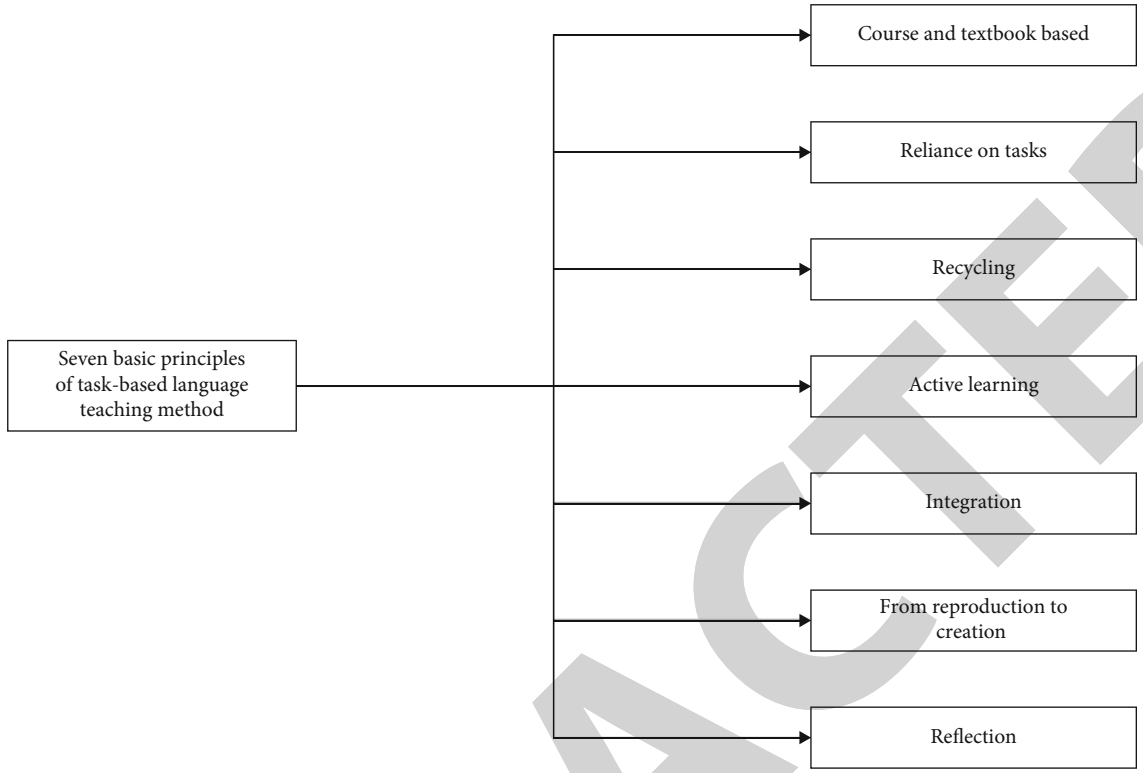

Figure 3: Seven basic principles of task-based language teaching method.

learning the language used in task language instruction. Students can use all the language skills they have learned or been exposed to. Teachers should encourage students to listen for meaningful expressions but should not overemphasize accuracy and precision in language use. Promote connections between classroom activities. In homework language instruction, a lesson can be designed as one large task that can be divided into several smaller tasks to form a task chain. The former is the basis of the latter, and the latter is the continuation and development of the former.

3.3. Methods and Formulas. The Apriori algorithm model of data mining algorithm is used in the fourth part of results and analysis of this thesis to analyze the application of English task-based language teaching method for a selected elementary school, middle school, high school, and university in A region. The Apriori algorithm model is described below.

The Apriori algorithm model finds all database items and item sets that occur frequently in the database by performing multiple scans of the database items to calculate the support of the item sets [19]. The frequency of these items must be at least as frequent as the predefined minimum support frequency. The frequent itemsets then generate a set of strongly associated rules, which in turn must satisfy their minimum reliability and minimum support, respectively. The Apriori algorithm requires multiple scanning cycles of the database. K The value of the first scan requires first $k(k-1)$ using the results of the first scan to k generate Ck the candidate item set, then determining the C k support degree during the scan, calculating the frequent item set at the K end $k1$ of each k scan, and Ck ending the algorithm when the candidate item set is empty [20].

The Apriori algorithm model can be divided into two steps.

Step 1: linking

To find, lk the $l(k-1)$ candidate set is generated by k linking CK with itself. Assume that l_1 with l_2 is l_{k-1} the set of items in. $l_i(j)$ is l_i the item set j of items. For $(l_1(1) = l_2(1)) \cap \cdots \cap (l_1(k-1) = l_2(k-1))$ example, l_1 can l_2 be connected with

Step 2: pruning

K all subsets of items, which must be sequent sets.

The process is as follows.

Input: database D minimum support min – sup threshold (1)

$$\begin{gathered} \text{begin}, \\ L1 = 1, \\ \text{for}(k = 2\,; lk - 1 \neq \varnothing)\text{do}, \\ CK = \text{Apriori} - \text{gen}(lk-1), \\ CT = \text{subset}(ck, t), \\ lk(ck, c.\text{count}), \\ \text{Return } LI \cup L2 \cdots \cup Lm. \end{gathered} \tag{1}$$

4. Results and Discussion

4.1. Experimental Discussion. This subsection investigates the application of English task-based language teaching

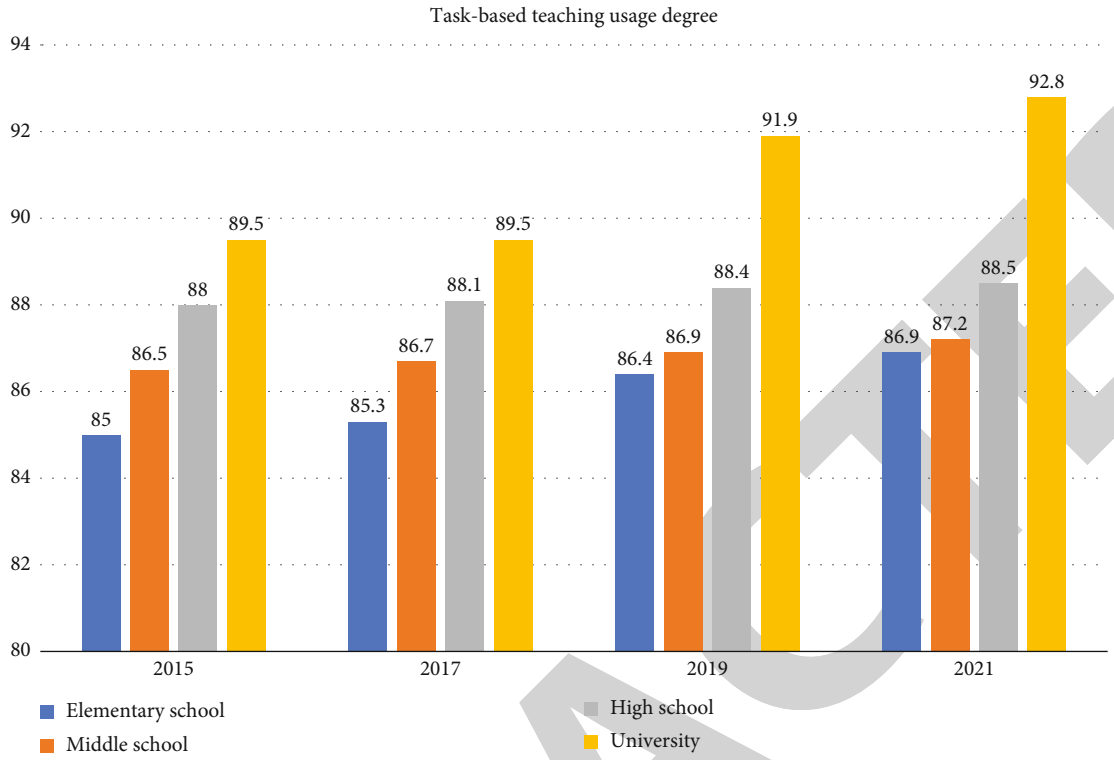

Figure 4: Usage of task-based teaching.

method for a selected primary, middle, high school, and university in region A by using the A-priori algorithm model in data mining algorithm.

(1) Study on the usage degree of task-based teaching

Assuming that the usage of task-based teaching scores out of one hundred, the analysis of the data shows that the usage of task-based teaching in elementary schools, middle schools, high schools, and universities in region A has gradually increased during the period of 2015-2021, as shown by the usage scores of task-based teaching in elementary schools from 85 to 86.9, middle schools from 86.5 to 87.2, high schools from 88 to 88.5, and universities from 89.5 to 92.8. Regardless of the level of English classroom learning, the usage of task-based teaching is gradually increasing, with the highest usage in college, because college English classrooms are more open, so the application rate of the comparative English teaching mode is greater than that of elementary, middle and high school. As shown in Figure 4.

(2) The degree of students' English learning comprehension under the comparison of task-based teaching mode and traditional teaching mode

Assuming that students' English learning comprehension degree scores out of one hundred, the data analysis shows that students' English learning comprehension degree is higher under the task-based teaching mode in elementary school, middle school, high school, and university in region A. Specifically, under the task-based teaching mode, students' English learning comprehension degree scores from elementary school to university range from 91.5 to 95.6, with the comprehension degree above 90, and under the traditional teaching model, students' English learning comprehension scores are above 80, which is much lower than the task-based teaching model, as shown in Figure 5.

(3) Students' learning initiative under the task-based teaching mode compared with the traditional teaching mode

Assuming that students' learning initiative scores out of one hundred, the data analysis shows that students' English learning initiative is higher under the task-based teaching mode in elementary school, middle school, high school, and university in region A. Specifically, under the task-based teaching mode, students' English learning initiative scores from elementary school to university range from 92.5 to 96.6, and the degree of understanding is above 90, while under the traditional teaching mode, students' English learning initiative scores above 80, which is much lower than the task-based teaching model, as shown in Figure 6.

(4) Teachers' participation in task-based teaching mode compared with traditional teaching mode

Assuming that the teachers' participation score is one hundred, the analysis of the data shows that the teachers' participation is lower under the task-based teaching mode in elementary schools, middle schools, high schools, and universities in region A. Specifically, the participation scores

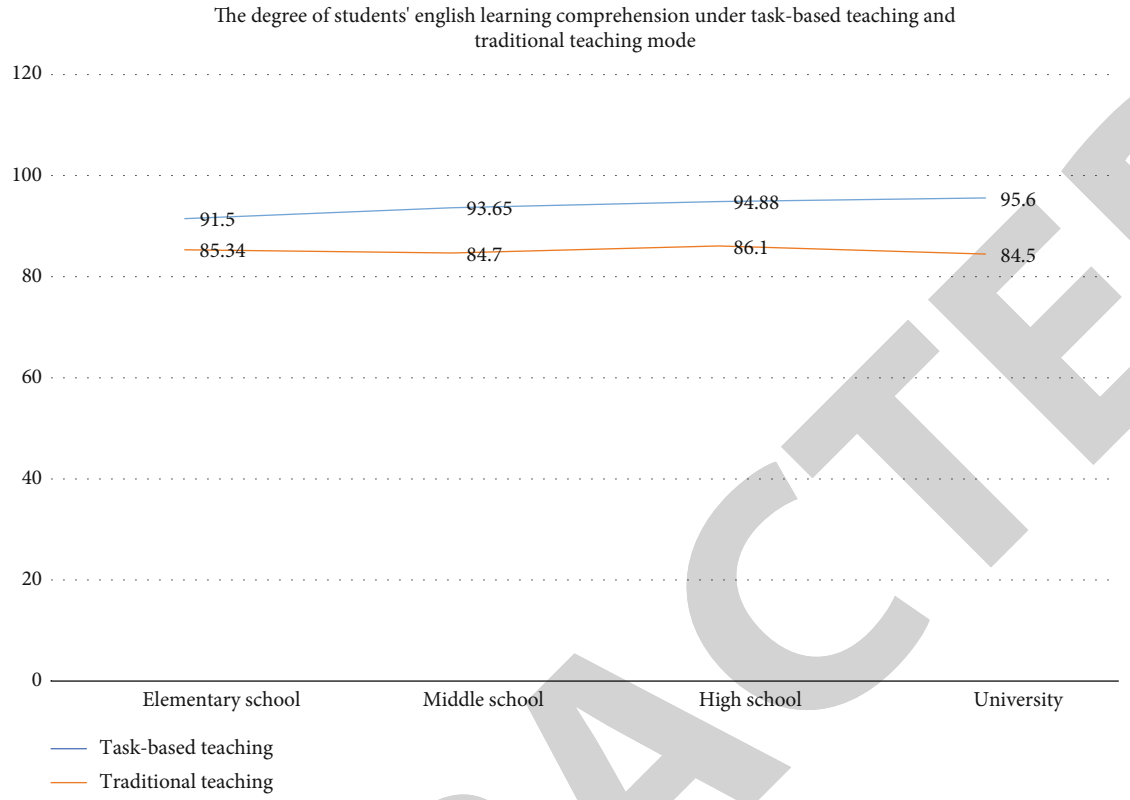

Figure 5: The comprehension level of students' English learning under the task-based teaching mode compared with the traditional teaching mode.

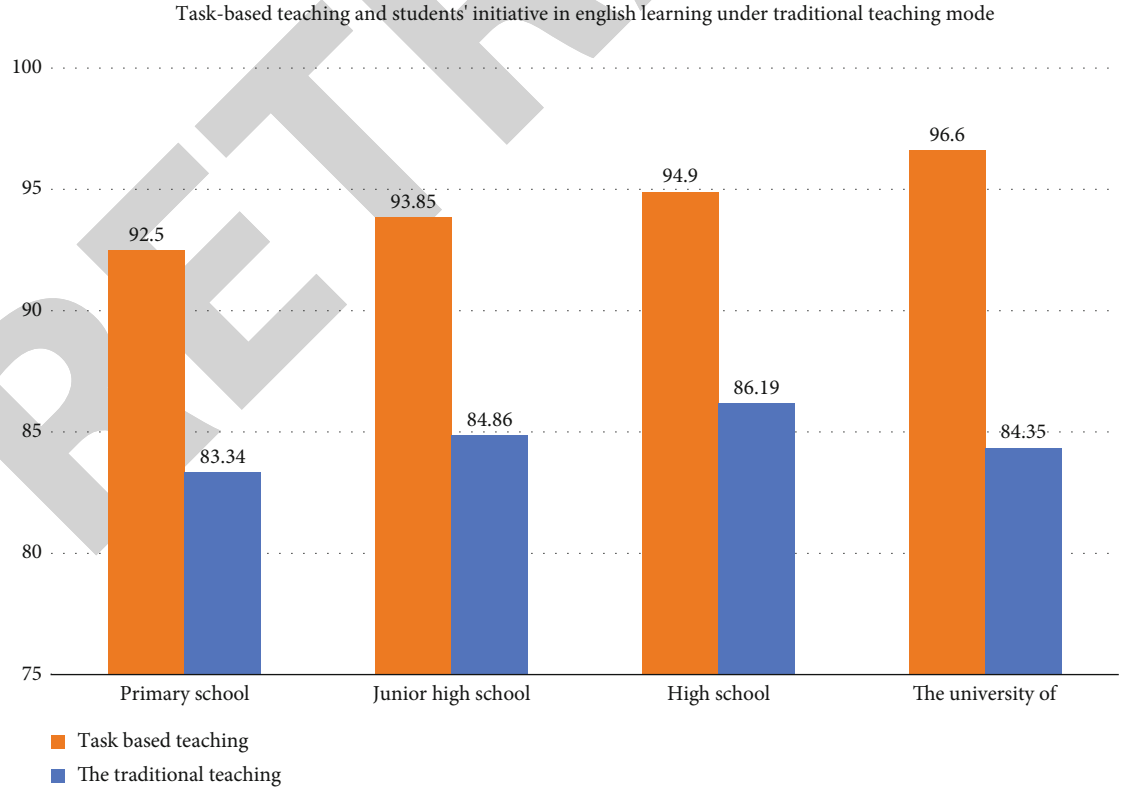

Figure 6: Students' learning initiative under task-based teaching mode compared with traditional teaching mode.

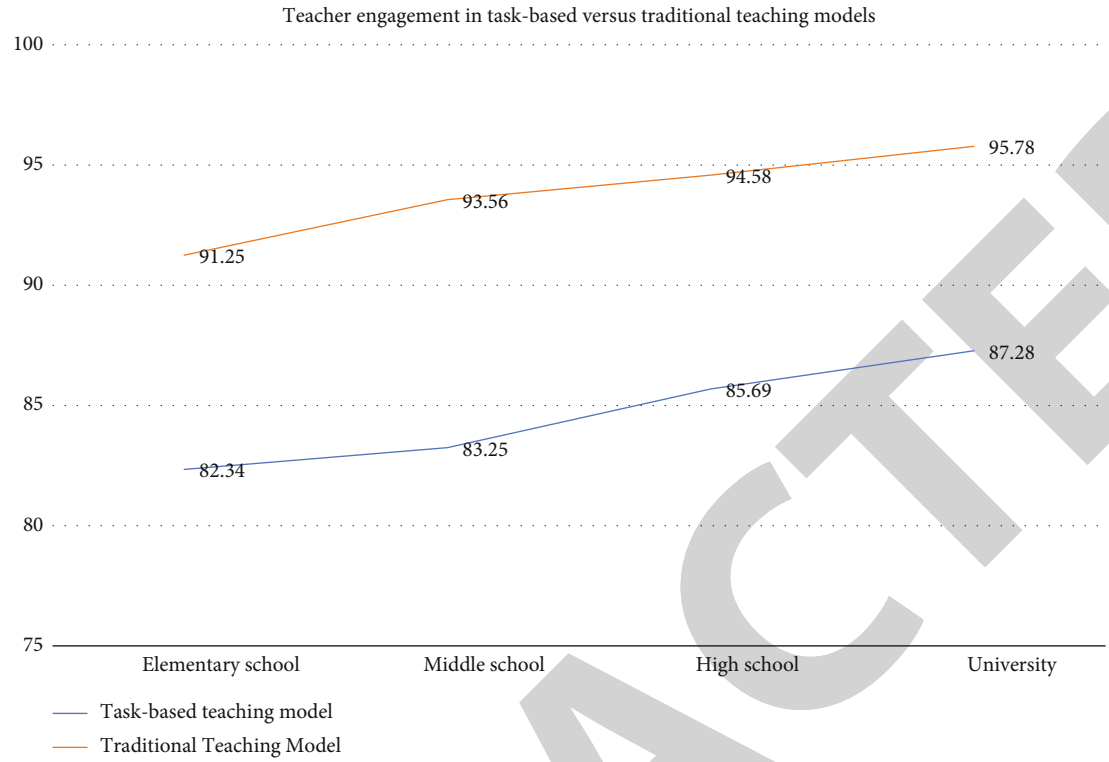

Figure 7: Teacher's participation under task-based teaching mode compared with traditional teaching mode.

of teachers from elementary schools to universities range from 82.34 to 87.28 under the task-based teaching mode, with the participation scores above 80, and the participation scores of teachers under the traditional teaching mode are above 90. Above, it is evident that under the task-based teaching model, teachers' classroom involvement is reduced, which can improve students' initiative and mobilize their learning ability, as shown in Figure 7.

(5) Satisfaction of teachers and students in task-based teaching mode and traditional teaching mode

Assuming that teachers' involvement is scored out of one hundred, the analysis of the data shows that the satisfaction of teachers and students under the task-based teaching mode is higher in elementary schools, middle schools, high schools, and universities in area A. Specifically, the satisfaction scores of teachers and students from elementary schools to universities range from 93 to 94.5, with satisfaction scores above 90, and the satisfaction scores of teachers and students under the traditional teaching mode are above 80. It can be seen that under the task-based teaching model, the satisfaction of teachers and students is high, as shown in Figure 8.

4.2. Analysis of the Results

4.2.1. Requirements for Teachers and Students in the Task-Based Teaching Mode. Through the study, it is noted that we can almost understand the task-based teaching method in English teachers' teaching and realize that the application of task-based teaching method in English reading classification is important to improve classroom efficiency, stimulate students' learning enthusiasm, and increase their motivation. Most of the English teachers surveyed also try to apply task-based teaching method to all types of English courses. The tasks are innovatively designed and close to real life, which help improve students' motivation and language application skills. However, due to lack of teaching experience, some teachers had problems with the necessary teacher role changes. At the same time, teachers should ensure that the demands on teachers increase when they apply task-based teaching methods in English reading classes. For students, most of them like the task-based teaching method, which helps them a lot in terms of self-confidence and sense of achievement. However, students are not very motivated to learn English. A few low-level students are afraid to use their language skills to express themselves, which will bring some obstacles to the implementation of the task-based teaching model.

(1) Requirements for English teachers under the task-based teaching model

First, teachers should thoroughly assess students' behavior and give them feedback. If they do not have faith and interest, they will stop their studies. Teachers should closely monitor students' performance to determine each student's learning level in order to provide appropriate feedback. Evaluation criteria should be clarified accordingly. With the implementation of the reform of the student selection system in 2012, the teacher-student assessment system has become more diverse. Education departments and schools

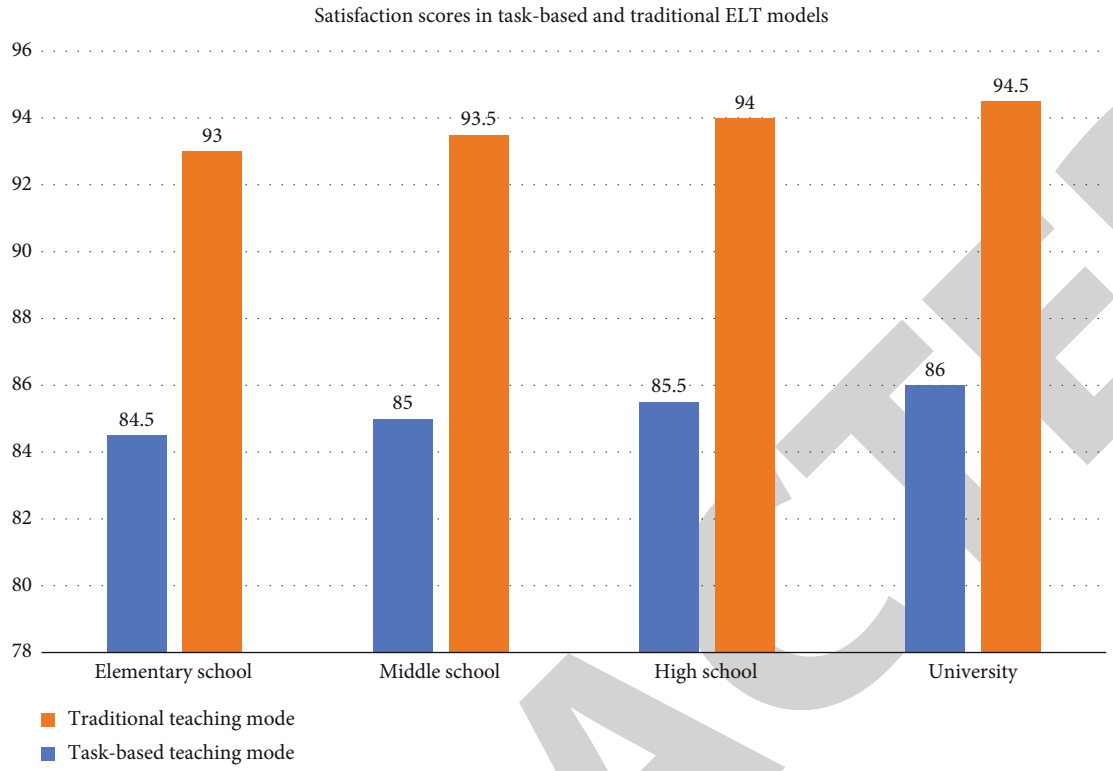

Figure 8: Satisfaction of teachers and students in task-based teaching mode and traditional teaching mode.

should take measures to minimize the number of classes. Teachers must shorten the class time in order to provide a dictionary. More importantly, teachers should regularly implement dictionary teaching strategies to enable students to effectively acquire a broader set of vocabulary.

Second, teachers should develop integrated language learning skills, motivate students, promote vocabulary changes related to students' life experiences and cognitive levels, and practice students' experiential and practical skills in the process of developing instructional activities. Participation and coeducation during task performance. In short, it is important to develop students' thinking skills, vocabulary interests, practical skills, and independence in the learning process.

Third, English teachers should be trained to be familiar with the textbooks and the correct teaching methods. Teachers should understand the educational concept that textbooks can teach students, rather than separating them directly from the textbooks. English teachers can make full use of textbooks as a curriculum and student needs, and it is crucial to understand their relationship to targeted instruction.

(2) Requirements for students in a task-based teaching model

Students should take every opportunity to increase their classroom motivation. In a terminology class, the instructor divides students into small groups to complete tasks. This is the time for students to participate in the class.

Second, students should stay motivated while studying the dictionary. Positive feedback in class helps teachers and students build confidence and facilitates dictionary learning and instruction.

Third, students should be as active as possible in communicating with the teacher in English. Students should develop a sense of correctness and not assume that it is right to attend all English classes and not speak English. Do not feel shy or anxious in front of students who do not speak English. Students should know that the more they practice, the more skills they will acquire.

(3) Stages required in the task-based teaching model

In English classes, the learning process can be divided into three stages: preassignment preoperative stage, and task stage and postoperative stage. In preassignment, the teacher instructs the students and the teaching tasks are undertaken by the students. The tasks are mainly for students. By learning in groups, students can complete the tasks and report the completion of the task group to the teacher and students after completing the tasks. Teachers and students analyze and evaluate the practice, clarify the teacher's priorities and difficulties, and strengthen the most important and difficult aspects.

The assignments must be close to the students' lives. An important feature of task language teaching is the authenticity of its content. Nowadays, with English learning in China, what we lack most is a realistic language environment. Therefore, teachers should take students' interests and interests into full consideration when choosing course content and choose the content of the selected topics according to students' interests and preferences. This not only improves

their interest in learning but also stimulates their enthusiasm for learning. In addition, the training objectives are met. The task must be clear that English teaching must aim at improving students' overall language skills. Therefore, teachers must design the curriculum in such a way that the language skills required by students are identified and developed accordingly to their learning abilities.

Information input should be considered when designing assignments. Students should use some information to complete the assignments given by the teacher. Students do not complete assignments based on information. If there is too much information, students will feel psychological pressure. Secondly, it is important to ensure the quality and quality of the information. Collaborate with students on training activities. When designing tasks, students' knowledge level should be considered. Students are easily interested in new things, so teachers must consider students' psychological characteristics when designing tasks and diversifying teaching activities.

After students are divided into groups, the teacher assigns the assignment to each group. This allows students to learn in a relaxed atmosphere, with students talking and communicating freely. In this situation, students can gain some achievement and learn more actively. Helping each other not only improves their learning ability but also improves their communication skills. After each group of teachers works, they can ask the other members of the group to assess the performance of the students in that group and to identify deficiencies and shortcomings in language use. After several group presentations, teachers ask students to summarize the most important points of the class in a circle format and explain the most important points in case the students are less competent. In such an interactive classroom, students and the teacher can enhance communication, cooperation, and mutual understanding.

4.2.2. Measures to Promote the Application of Task-Based Teaching Model. Based on the above research, appropriate measures were taken to promote the application of the task-based teaching model. Based on the theoretical guidance and practical training for English teachers in schools or the Ministry of Education on specialized teaching methods, educators can conduct regular theoretical trainings to help teachers understand task-oriented teaching methods. In addition, training materials could include the process, characteristics, structure, stages, and principles of results-based learning. Second, teachers should be encouraged to learn collaboratively so that they can learn from each other in a group exchange, improving each teacher's skills and ultimately developing collective wisdom. Third, school administration should organize and encourage teachers to actively participate in the government curriculum and explore special teaching methods that are more suitable for students' development by combining their teaching practices and theoretical knowledge of tasks.

When designing reading and writing tasks, teachers should use reading flexibly according to the characteristics of reading materials and students, combined with the content and the specific characteristics of students, especially those at lower levels. Instructors should design tasks that focus closely on the reading material, from light to difficult. At the same time, instructors should consider the subjectivity of students when planning their work and ensure that they express themselves in their work.

In order to establish students' dominance in the setting of teaching methods in English reading courses, the new curriculum should require teachers to develop students in their practice in order to achieve individualized and active learning. Therefore, English teachers must consider the status of students as active creators of knowledge and learning activities when applying task-based approaches to teaching English. At the same time, teachers must create a positive learning atmosphere that attracts students' attention and stimulates their thinking. In such a learning environment, students can be motivated to accomplish their tasks. In addition, English teachers should maintain classroom discipline to ensure a lively classroom atmosphere.

Change the teacher's role in the teaching process in a timely manner. Teachers must understand that they are no longer at the center of teaching and learning but have evolved into developers, organizers, planners, and controllers according to their teaching activities. Teachers should take on the role of a monitoring and supervisory body to ensure that each group is given equal time and opportunity to perform their tasks in an effective and orderly manner. At the same time, teachers should encourage students to change their past passive learning attitudes and encourage active participation in teacher-led activities. Teachers should encourage students, especially the less educated, to express themselves and develop self-esteem, thus creating a strong motivation to learn.

To establish a perfect English reading scoring system, the application of task-based teaching mode in English learning should be fully in line with the content: not only students' language reading ability should be studied but also their learning motivation and English reading strategies. Secondly, the assessment form of English reading training program should be diversified, including preparation assessment and final assessment. Through these two assessment methods, we value not only the assessment of learning outcomes but also the assessment of learning processes. In addition, teachers can rely on nonregular assessments, such as interviews and observations.

5. Conclusion

In the 4G era, various terminal English teaching programs or applications have had an impact on English teaching. With the advent of the 5G century, smarter and deeper "Internet +" ELT software, hardware, or applications, such as smart English textbooks and smart English pencils, will further drive explosive growth. Classroom English teaching should not follow the same old path but should actively learn new technological achievements and apply them practically in all aspects of classroom English teaching. This study analyzes the needs of English teaching in the context of big data 5G IoT scenario, new curriculum reform, and theories related to English teaching methods in order to explore

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Retraction

Retracted: Mental Health Education in Primary and Secondary Schools Based on Deep Learning

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] C. Wang and Y. An, "Mental Health Education in Primary and Secondary Schools Based on Deep Learning," *Journal of Sensors*, vol. 2022, Article ID 9672254, 5 pages, 2022.

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Research Article

Mental Health Education in Primary and Secondary Schools Based on Deep Learning

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Strengthening the mental health education of primary and middle school students is a key measure to lead their healthy growth. This paper takes mental health early warning as the starting point to carry out research on mental health education in primary and secondary schools. Aiming at the defect that the existing methods cannot effectively warn the mental health of primary and secondary school students, this paper proposes a mental health early warning research method based on the deep learning models. The method firstly obtains the mental health data of college students through the symptom self-rating scale. Then, a mental health prediction model combining convolutional neural networks (CNN), deep residual networks (ResNet), and long short-term memory (LSTM) is adopted. Through in-depth processing and analysis of mental health data, the mental health status of students can be determined. Experiments show that this method can effectively improve the accuracy of mental health early warning compared with the currently commonly used mental health early warning methods.

1. Introduction

With the increasingly fierce social competition, the primary and secondary school students are facing multiple pressures such as learning and interpersonal relationships, and mental health problems frequently occur [1–3]. Traditional mental health monitoring methods are relatively passive and inaccurate. People need to actively seek consultation with a psychiatrist and conduct tests to determine whether they have a disease. The main methods of diagnosis and treatment used by doctors are the form of communication and questionnaires, and the results of diagnosis are affected by the subjective judgment of doctors to some extent [4–6]. It is worth noting that the effect of traditional mental health monitoring methods in the prevention of mental health diseases depends greatly on the degree of people's attention to mental health. And there is a lack of suitable biomarkers to quantify the degree of mental disease development and the effect of drugs. With the development of artificial intelligence technology, researchers have begun to predict mental health through intelligent algorithms and analyze people's emotions and psychological states through analysis of human biological signals, facial expressions, body language, and other aspects. Judging from the existing literature, most of the currently used mental health early warning systems are based on traditional machine learning algorithms, such as back propagation (BP) neural network and decision tree algorithm, which require a large amount of calculation, and the accuracy of early warning is not high. In recent years, new artificial intelligence algorithms represented by deep learning have developed rapidly. From the reported results, deep learning models can dig deeper into the internal structure of data and obtain more reliable results than traditional machine learning algorithms [7–10].

Based on the background of mental health prediction, this paper carries out research on mental health education of primary and secondary school students. First of all, the mental health data of primary and middle school students is collected in the form of symptom self-rating scale, which is usually a high-dimensional data set, as the basic basis for mental health prediction. On this basis, a mental health prediction model combining convolutional neural networks (CNN), deep residual networks (ResNet), and long short-term memory (LSTM) is designed. CNN can effectively

extract the hidden features of high-dimensional data, but recurrent networks can learn historical information. Research shows that recurrent networks are more suitable for processing time series, and combining CNN and recurrent networks can take advantage of both. Reference [11] uses a convolutional LSTM to identify the original time series data of the signal, and its model performance exceeds the simple LSTM model in terms of recognition ability. Reference [12] used the deep network built by CNN and LSTM to classify and identify vibration signals. On the basis of previous research, this paper proposes a mental health state prediction method based on ResNet combined with LSTM [13–16]. Taking the collected mental health data of primary and middle school students as the model input, the 1DCNN network is used to extract the signal feature information, and the ResNet improves the model training depth to avoid the disappearance of the model gradient. Then, the LSTM network learns the feature information and finally realizes the classification and prediction of mental health status [17–20]. The method proposed in this paper can effectively combine the advantages of different deep learning models, thereby further improving the reliability of the final prediction results. Experiments are carried out based on the collected data sets, and the results show that the proposed method has higher prediction accuracy than traditional machine learning methods.

2. Method Description

2.1. 1DCNN. CNN is a feedforward neural network with representation extraction and learning capabilities. It is mainly composed of convolutional layers, pooling layers, and fully connected layers. It has been widely used in two-dimensional data classification problems such as image recognition. The convolution layer extracts features from the input data through the convolution kernel and continuously fits the local hidden features of the data during the training process. The pooling layer performs downsampling and dimension reduction processing on the data to complete parameter sparseness and reduce the amount of data. Due to the large size of the input data and the convolution kernel and many network parameters such as weights and biases, the parameter sharing method is commonly used to reduce the number of network free parameters and speed up the network training process. The time domain data of the interference signal discussed in this paper is one-dimensional time series data, so a 1DCNN is used, and whole basic formula is as follows:

$$Z_k^{l+1} = \sum_{\omega_k} \left[Z_k^l \times \omega_k^{l+1}(x) \right] + b_k^l, \tag{1}$$

where Z^l and Z^{l+1} are the convolution input and output of the $l+1$ layer; b_k^l is the deviation; ω_k^{l+1} is the convolution kernel of the corresponding node of the $l+1$ layer, and M is the set of convolution kernels.

The max pooling formula is

$$s_k^l = \max\left(y_k^l(hn-1), y_k^l(hn) \right), n = 1, 2, \cdots, \frac{m}{h}. \tag{2}$$

In equation (2), h represents the pooling step size, and m is the number of elements in the sequence y_k^l. After multilayer convolution and pooling operations, the extracted multicolumn deep-level feature sequences are integrated into one column in the flat layer, which lays a data foundation for subsequent time series feature extraction.

2.2. ResNet. With the increase of the number of layers of the CNN model, there will be problems such as loss of features and incomplete information between multiple hidden layers, resulting in disappearance of gradients and reduced network performance. The main approach of residual networks to address this problem is to add linear direct paths while convolutions handle nonlinear transformations. Its basic unit structure is shown in Figure 1.

It can be seen from the figure that between the input x_l and the output x_{l+1}, the two convolutional layers in the middle are set up with cross-layer connections. The input of the shallow layer is directly connected to the end position. Since the weight of the direct cross-layer connection is 1, so in the process of layer-by-layer mapping, the problem of network gradient disappearance caused by the nonlinear processing of the convolution layer $F(x_l)$ being less than 1 can be avoided. Through the residual operation, the network performance cannot be degraded while increasing the depth.

2.3. LSTM. Recurrent neural network (RNN) is a deep learning algorithm often used in processing complex sequence data. The network takes sequence data as input and performs recursive processing in the evolution direction of the sequence. A neural network in which all cyclic units are connected in a chain can be used to process the information of the sequence structure. It reflects the transmission and accumulation of information from the front to the back in the time dimension and can expand the time characteristics. The state of the hidden layer of the RNN at each moment is determined by the current input and the state of the previous hidden layer at the same time, the memory capacity is limited, and it is easy to cause the problem of gradient disappearance. The LSTM network introduces forgetting gate, input gate, and output gate unit on the basis of the conventional cyclic neural network to control the state iteration of the LSTM unit and controls the memory information. The acquisition of input information and the transmission of output information are obtained through the gate coefficient, improving the classification network.

The difference between LSTM and general RNN is mainly in the calculation of the hidden state of the recurrent network. The basic structure of LSTM is shown in Figure 2. At time t, the state of the LSTM unit C_t is determined by discarding the useless information of the unit and retaining some useful information. The state of the hidden layer h_t at this moment is determined by the useful information selected by the output gate C_t. The calculation process is as

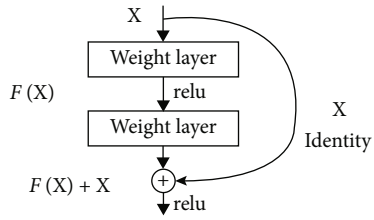

Figure 1: Basic structure of ResNet.

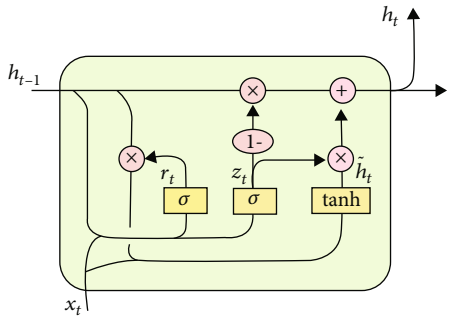

Figure 2: Basic structure of LSTM.

follows:

$$h_t = o_t \tanh(C_t), \tag{3}$$

$$C_t = f_t C_{t-1} + i_t \tilde{C}_t, \tag{4}$$

where f_t, i_t, and o_t are the gating coefficients of the forget gate, input gate, and output gate, respectively; $\tilde{C}_t$ represents the update vector of the input unit state at time t. The calculation formulas are as follows:

$$f_t = \sigma\left(W_f \times [h_{t-1}, x_t] + b_f\right), \tag{5}$$

$$i_t = \sigma(W_i \times [h_{t-1}, x_t] + b_i), \tag{6}$$

$$o_t = \sigma(W_o \times [h_{t-1}, x_t] + b_o), \tag{7}$$

$$\tilde{C}_t = \tanh(W_c \times [h_{t-1}, x_t] + b_c). \tag{8}$$

In the above equations, W_f, W_i, and W_o are the weight matrix of each gated node; W_c represents the memory weight; b_f, b_i, and b_o are the bias of each gated node; b_c represents the memory cell bias; and σ represents the sigmoid function.

LSTM realizes its special long-term and short-term data memory function through three gates: input gate, forget gate, and output gate, which makes the model more suitable for learning the characteristics of data that are associated and continuous before and after.

2.4. Procedure of Mental State Evaluation. In this paper, a mental health prediction model based on the combination of CNN, ResNet, and LSTM is constructed. Based on the mental health data of primary and secondary school students, the mental state and health level are judged. The basic process of the proposed method is shown in Figure 3, and the main steps are described as follows.

Step 1. Since the input of the LSTM layer is sequence data, the mental health data is firstly folded and input to the subsequent network layers.

Step 2. Through a convolution and two residual block operations and then through the maximum pooling layer and the flat layer, the dimension of the data is reduced.

Step 3. Sequence expansion of the output data of the flat layer is performed. And the two-layer LSTM layer is input to extract time series information, and finally, the extracted features are obtained.

Step 4. The Softmax function is employed to output the probability value. The type of mental state is determined according to the probability distribution, and the correct rate according to the label is output.

3. Experiment and Analysis

3.1. Dataset Collection and Preprocessing. During the mental health data collection and preprocessing, the symptom self-assessment scale was distributed to 500 students in a middle school, and psychological data was collected. In order to quantify each student's psychological state, the student's mental health data structure was constructed as (student number, somatization, interpersonal sensitivity, obsessive-compulsive symptoms, depression, anxiety, terror, hostility, paranoia, psychosis, and others). In the experiment, 300 pieces of mental health data of college students were randomly selected as training samples, and the remaining 200 pieces of data were used as test samples. The collected mental health data structure of each student is represented as a one-dimensional column vector with 11 elements. Therefore, both training samples and test samples in the experiment can be represented by a one-dimensional column vector with 11 elements.

3.2. Result and Discussion. In this paper, a deep learning model is used to predict the mental health data of primary and secondary school students, and the proposed method is verified according to the collected data. The experiment compares and analyzes the method proposed in this paper with the traditional mental health prediction method based on BP neural network and decision tree model. Five experiments are carried out for each method, and the training samples and test samples used in each experiment are randomly selected. And the best early warning accuracy and average prediction accuracy of the five experiments are taken for the mental health status. Table 1 shows the prediction results of mental health status by various methods. It can be seen that the prediction accuracy of the proposed method is higher than that of the two contrasting methods. The reasons for this performance advantage can be analyzed from two aspects. One is the advantage of deep learning models. Deep learning algorithms can better process mental health

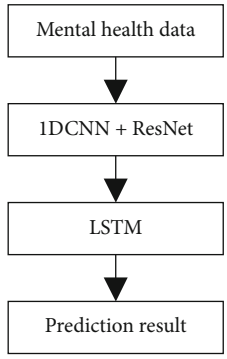

Figure 3: Basic process of the proposed method.

Table 1: Comparison of performance of different methods.

Method	Average classification accuracy (%)
Proposed	93.2
BP	87.1
Decision tree	89.2

Table 2: Performance of different methods at different repetitions (%).

Method	10	15	20	25	30
Proposed	93.5	93.9	94.1	94.2	94.1
BP	87.4	88.1	88.3	88.3	88.2
Decision tree	89.3	88.9	89.1	89.2	89.3

data and discover patterns, thus helping to improve the accuracy of subsequent predictions. The second is that this paper applies three different deep learning models jointly, which combines their advantages and further ensures the reliability of the prediction results.

In order to further verify the robustness of the proposed method, the experiment further increases the number of repetitions. Table 2 gives the prediction accuracy under multiple different repetitions (10, 15, 20, 25, and 30). With the increasing number of experiment repetitions, the average prediction accuracy of various methods tends to be stable. From the results, the prediction accuracy of the method in this paper always maintains the highest level, reflecting its superior performance in mental health prediction.

4. Conclusion

In this paper, a method based on symptom self-rating scale and deep learning is proposed for the psychological state assessment in the mental health education of primary and secondary school students. First, the mental health parameters of the students are obtained through the symptom self-rating scale, and then, the feature vector is constructed. Taking the feature vector as input, train a deep learning model combining 1DCNN, ResNet, and LSTM. The trained model can judge the students' mental state and health level according to the results of the self-rating symptom scale of students, so as to provide improvement strategies for the targeted development of mental health education for primary and secondary school students. In the experiment, the proposed method is tested with relevant data and compared with the existing mental health prediction algorithms, and the results reflected the effectiveness of the method.

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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Retraction

Retracted: Intelligent Building Space Layout and Optimization Design Method Based on Biological Population Simulation

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] C. Wu and Y. Lin, "Intelligent Building Space Layout and Optimization Design Method Based on Biological Population Simulation," *Journal of Sensors*, vol. 2022, Article ID 6246576, 9 pages, 2022.

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Research Article

Intelligent Building Space Layout and Optimization Design Method Based on Biological Population Simulation

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Smart buildings can store various types of data, analyze data at a faster speed, and quickly provide users with the most accurate and high-quality intelligent services through technical means. The main purpose is to meet the needs of users, to provide communication and a series of knowledge services for all professional participants, and to provide comfortable working resources and working environment for all professional participants to ensure the smooth implementation of the project and meet the construction engineering requirements. In this study, the spatial layout and optimization of intelligent buildings are carried out based on biological population simulation, and the following conclusions are drawn: (1) The emergence of multicore or multicore graphics converters reduces the cost and popularity of high-performance software platforms, and provides faster computing speeds for applications. A new platform and implementation method have been developed. Comparing marine biopopulation models relies on the i4Ocean platform. The i4Ocean platform is a computer platform for seascape information and virtual reality applications, including view management, production engine, and MVC core framework. (2) The swarm model simulates the movement of fish in a virtual ocean. Determine their behavioral changes based on determined behavioral conditions (e.g., in position, position, and velocity). As everyone in the group moves, the entire group is monitored for behavior. (3) Intelligent buildings involve many aspects of the social machine, such as building construction, which not only affects architecture, but also design. Smart construction helps improve quality, shorten production time, save resources, and control costs. It is an important part of the structural transformation of the supply side of the construction industry, and an important tool for the structural adjustment and modernization of the construction industry and greenhouses. (4) X2View is like the most popular configuration king, with integrated functions. Project software is placed on the X2View and sent to the door or touch screen for processing and monitoring. In the driver configuration interface, you can set the application frame time of the monitoring node and the real-time measurement time of the record value recording time frame.

1. Introduction

With the development of the economic level, the scale of houses is increasing, and the construction technology is becoming more and more mature. Traditional construction methods cannot meet complex construction requirements [1]. Smart building is a new concept that emphasizes sustainable development, energy conservation and reduction of enclosed gas emissions, protection of natural resources, and core management of greenhouses. Use modern tools to implement a full range of cleaning. Smart buildings require specific applications to integrate new information technologies and the construction industry. 4D-CAD and BIM technology integrate building material information model, conduct dynamic research and statistical analysis on the relationship between technical cost materials and construction progress, help understand the progress of project implementation, and quickly detect and solve the relationship control between structures. Resources and costs improve project management level and efficiency [2]. In the detailed

analysis of lean manufacturing, an interaction matrix is established, their interactions are discussed, individual interactions are analyzed, and future application projects of lean manufacturing and BIM technology are compared. Analyze the advantages and disadvantages, and prepare a similar interaction matrix. The collaborative application of dynamic manufacturing and BIM technology is proposed, and the negative impact of the combination of the two is avoided as much as possible [3]. Based on new information technologies such as BIM, Internet of Things, personal data processing, and 4D vision, considering the concept of smart home, there are more and more management methods for smart homes and more and more management methods and processes. With the improvement of scientific and technological level and the promotion of new information technology, the traditional construction industry has introduced a new construction mode. The new building model combines IT building construction technology with digital and intelligent building construction. Smart city is an important part of urban architecture [4]. According to the characteristics of the current construction industry, in order to better stimulate its survival, the main goal is to use the high-tech system innovation of the construction industry to promote the intelligent development of housing. In recent years, the concept of smart home has been considered and continuously improved [5]. The evaluation standard requires intelligent buildings to implement the concept of sustainable development, with low-carbon combustion and environmental protection as the main goals of the project. All participants in the Environmental Assistance Program have a collaborative platform for providing information. Smart building is a good platform [6], and the smart home platform is supported by BIM technology, cloud technology, and Internet of Things technology. All these technologies operate on a huge IT database that can be understood through the integration of traditional manufacturing tools and information technology [7]. Smart buildings usually focus on five major information technologies, such as BIM technology, cloud computing, and mobile Internet, solve key problems in various fields of construction projects, and create a knowledge-based office environment with multiteam participation and collaborative development. The main goal is to meet the needs of owners. Intelligent building is a form of construction with similar characteristics of the times, which is different from traditional construction forms. Based on the organizational structure, knowledge construction requires all participants to work together on a project [8], sharing information on a knowledge platform to make the project more meaningful and effective. In the field of machine quality and safety management, traditional manufacturing organizations have formulated a number of quality and safety management systems and appointed multiple quality and safety inspectors to manage the factory [9]. With the help of information technology, it is possible to monitor the construction site at any time, reduce operations, and provide an alarm response when problems arise. The use of visual simulation technology for construction sites must be addressed where problems arise. For project cost, statistics used to provide correct machine size for project cost. Then, compare it to the timeline to make sure people, equipment, machinery, and equipment are properly organized. For information sharing [10], a knowledge base is established to collect information about projects in various ways and to incorporate professional information and resources provided during the development of professional projects into appropriate times. The types of services and applications in a building are location-based, and each location can only access nearby locations and control the data interaction between nearby locations [11]. From the perspective of behavior process, group behavior and group robot formation are similar in operation. Individuals in a group cannot simply follow the global extension law, and may be affected by factors such as individual behavioral characteristics. To show that individuals in a sample can be combined, combinations must be considered. Aggregation is an idea of the aggregate strength of a group, the final size of the aggregate of the group. The smaller the final size, the greater the density of the aggregated population and the stronger the aggregation. Individuals in the herd moved to one location over a period of time, but it was not stated whether the individuals would remain in the herd area or remain active in the area. This should also be investigated in cluster models to determine the ultimate nature of the individuals. Stability analysis of the samples was performed [12]. The stabilization time of the population is related to the initial position of the individual, and in the simulation test, the initial position of the individual is determined by a set of random values. When studying the cluster confirmation time through the simulation test, for each set of parameters, the average value of multiple tests was taken as the cluster confirmation time under the set of parameters. The herd stabilization time could not be determined to minimize error in test results. Thousands of simulations are often used, such as video games, virtual reality, security simulations, and movie animations. A range of methods has been developed to achieve reliable and efficient simulations of group behavior. The way in which the model is applied is unique to each client [13]. Most groups are small groups of many people with similar behaviors. There is a way to compare the properties and behavior of subgroups within a group. These methods focus more on controlling for comparative group formation rather than natural group behavior in the real world. Some current data collection methods, such as motion capture tools or methods to automatically retrieve walking trajectories from group video tapes, are difficult to obtain the real group motion data required in a data-driven process. Researchers have systematically studied the research theories, cutting-edge technologies, related software systems, and new intelligent tools and software of intelligent computers required for new buildings and their applications and are constantly improving and maturing [14]. Most swarm simulation techniques are based on some form of intelligent control optimization technology, which uses intelligent optimization technology to reflect the uniqueness of swarm space group simulation. Able to represent the variability of multiple objects and the variability of motion, but the computational cost is very high. There are also algorithms that compare the characteristics of insects in the environment, such as ant

colonies and bee colonies. To a certain extent, it can exhibit some form of group behavior, but in some specific cases, it is likely to collapse, such as the whirlpool ant, a phenomenon caused by a high dependence on the ant colony. Intelligent building grouping is the process by which people in a group cooperate with each other to make all intelligent actions happen. Simulated physics methods were originally considered for the construction operations of swarm robots. Use the law of universal extension to define how individuals interact. Through this interaction, the robots come together and share unique structures and geometries. Intelligent buildings are very in line with the concept of sustainable development, integrating life into all aspects of the project life cycle, using information technology to consume energy and green production, and can control the recycling of natural resources [15]. Sustainable development not only meets the requirements of power protection and environmental protection, but also meets the requirements of social and urban development.

2. Swarm Simulation and Intelligent Building

2.1. Group Motion Model. The global clustering model is to analyze and compare the comparative clusters. Models based on global control can better compare individual groups and have significant advantages in both model-by-model and overall planning and presentation. Since the group has been extracted as fine particles, it is suitable for massive parallelism. In the calculation, the more the number of particles, the higher the calculation speed. The disadvantage is that the group modeling cannot reflect the characteristics of individual behavior significantly, and the individual model is general. A form of collective action occurs when everyone demonstrates his or her own action. Individual group simulation can be adjusted individually for individual actions and attribute parameters. The complex and changeable group behavior can be understood through a small amount of local control, and it can be shown in different actions, which has a good simulation effect. And individual models are better and more efficient. Individual comparisons are used to simulate the movement of schools of fish, such as fish in an aquarium and sheep on grass. It is shown in Figure 1.

2.2. Intelligent Construction. There is a big difference between smart construction and traditional construction. Smart buildings can provide intelligent services to all project participants throughout the life cycle of the project. Data warehouse can store various types of data, analyze data at a faster speed, and quickly provide users with the most accurate and high-quality intelligent services through technical means. By considering the complex types of information that emerge from the perspective of knowledge creation, different types of communication, interaction and advancement are allowed to achieve the goal of knowledge. The Internet of Things technology is applied to the intelligent platform, through the interaction between people, to create an intelligent neural network platform, to strengthen the communication between different users, to avoid island communication, and to achieve synergistic benefits. Integration is a feature of intelligent construction projects and technology integration, to complete the integration of various information technologies and to integrate the core functions of construction projects. Technical support for smart manufacturing includes a variety of tools and unique features. The advantage of smart construction projects is the combination of different technical approaches to achieve the highest level of integration. The main purpose of smart buildings is to meet the needs of users, to provide communication and a series of knowledge services for all professional participants, and to provide comfortable working resources and working environment for all professional participants to ensure the smooth implementation of the project and meet the requirements of the construction engineering supervisor. Many issues arise after the project is completed (building management, building renovations, building operational renovations, etc.), and expert services are also available. It is shown in Figures 2 and 3.

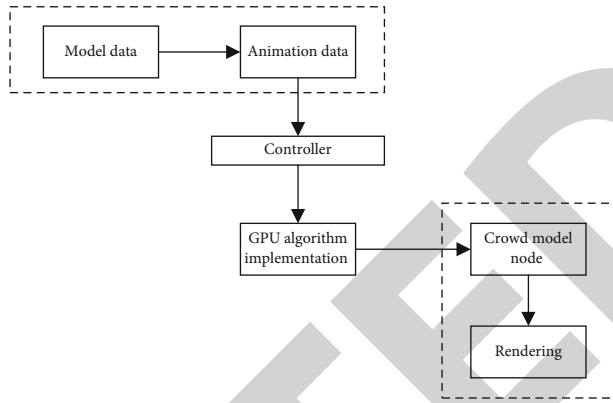

Figure 1: Population model.

3. Simulation Algorithm

Swarm simulation algorithm [16–20]

$$C_i = \prod_{i=1}^{n} a_{ij},$$
$$M_i = \sqrt[n]{C_i}. \tag{1}$$

Intelligent building

$$W_i = \frac{M_i}{\sum_{k=1}^{n} M_k}. \tag{2}$$

Take a group of individuals in n-dimensional space, and determine the particle mass as 1 and the position as a. Information about that location will be available to everyone else. For two people in a population, when the distance between individuals is greater than the value of w, they approach each other by pulling, achieving total aggregation.

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(\mathrm{AW})_i}{nW_i}. \tag{3}$$

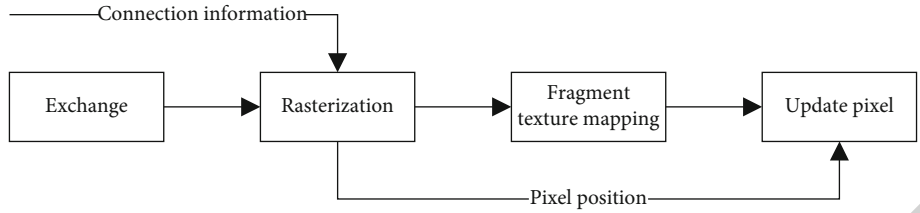

Figure 2: Integrated construction.

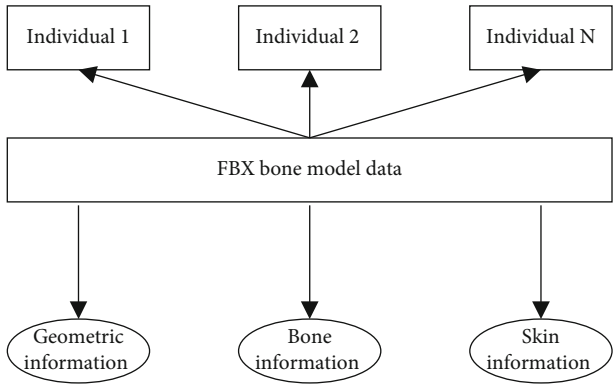

Figure 3: Intelligent construction data reuse.

Table 1: Initial detection value.

	C1	Boids	RVO	BIO
*S*11	1.61	1.62	0.11	1.43
*S*12	1.97	0.95	1.33	1.89
*S*13	0.48	1.68	0.48	1.22
*S*21	1.99	1.78	0.06	1
*S*22	1.26	1.24	0.42	0.64
*S*23	1.74	1.65	0.1	1.14
*S*24	6	7	10	6
*S*31	9	10	7	10
*S*32	6	5	8	10
*S*33	10	9	9	6

Group movement data

$$\mathrm{CI} = \frac{\lambda_{\max} - n}{n - 1}. \tag{4}$$

Dynamic manufacturing

$$\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{RI}},$$
$$\mathrm{CR} = \frac{b_1\mathrm{CI}_1 + b_2\mathrm{CI}_2 + b_3\mathrm{CI}_3 + \cdots + b_n\mathrm{CI}_n}{b_1\mathrm{RI}_1 + b_2\mathrm{RI}_2 + b_3\mathrm{RI}_3 + \cdots + b_n\mathrm{RI}_n}. \tag{5}$$

The matrix consists of the estimated m items and the initial data of n indicator values. Enter the metric values of the j metrics to be evaluated online. If the decision matrix of the evaluation index is x, ij is the ith object and the jth index value.

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{n1} & x_{n2} & \cdots & x_{\mathrm{nn}} \end{bmatrix}. \tag{6}$$

New information technology

$$P_{\mathrm{ij}} = \frac{x_{\mathrm{ij}}}{\sum_{i=1}^{m} x_{\mathrm{ij}}}. \tag{7}$$

Group simulation technology [21–23].

$$E_j = -n \sum_{i=1}^{m} \left(p_{\mathrm{ij}} \ln p_{\mathrm{ij}} \right). \tag{8}$$

Collaborative development

$$e_j = -\ln \frac{1}{n} \sum_{i=1}^{m} \left(p_{\mathrm{ij}} \ln p_{\mathrm{ij}} \right),$$
$$h_j = 1 - e_j, \tag{9}$$

where W can be thought of as a function of the natural force field and j represents the negative gradient of potential energy. Assuming the ability to move into space with a small force, the position that can be defined as hj represents the source of attraction in the environment, and n represents the equilibrium position where the potential field is zero.

$$W_j = \frac{h_j}{\sum_{j=1}^{n} h_j}. \tag{10}$$

Knowledge building

$$W_j' = \alpha W_j^* + (1-\alpha) W_j^{**}. \tag{11}$$

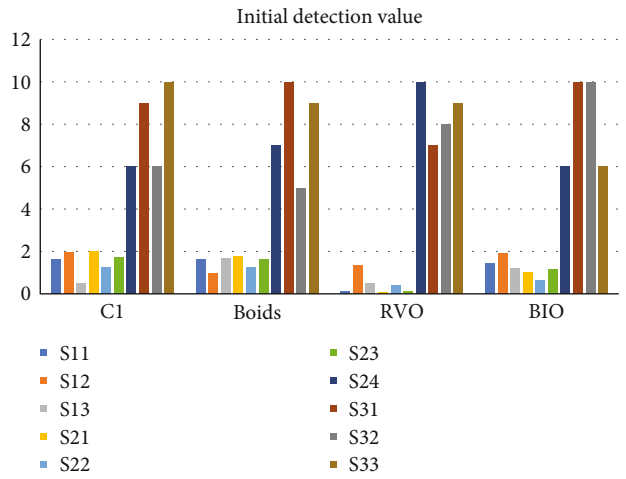

Figure 4: Initial detection value of the population.

Table 2: Relationship between the number of individuals and clusters.

M	eavg	ts	MI	Iavg	IT
2.75	3.14	3.39	4.81	3.21	3.72
2.47	3.38	3.37	4.71	2.99	3.84
2.1	3.47	3.91	4.67	3	3.44
2.15	2.01	3.64	4.04	2.45	3.56
2.07	2.45	3.54	4.22	3.06	3.43
2.47	3.27	3.17	4.59	3.11	3.64
2.36	3.92	3.16	4.31	3.02	3.03
2.65	3.93	3.98	4.73	2.96	3.24
2.79	2.87	3.93	4.91	2.38	3.38

Intelligent optimization technology [24–27]

$$Z_{\min} = \sum_{j=1}^{n}\left[\left(W_j' - w_j^*\right) + \left(W_j' - w_j^{**}\right)^2\right],$$
$$W_j' = 0.5W_j^* + 0.5W_j^{**}, \tag{12}$$
$$A^+ = \left\{\left(\max_{1\le i\le m} d_{ij}\right) | i = 1, 2, .., m\right\}.$$

Swarm machine

$$A^- = \left\{\left(\min_{1\le i\le m} d_{ij}\right) | i = 1, 2, .., m\right\}. \tag{13}$$

Cluster model

$$T = \left(r_{ij} - A^+\right)_{n\times m},$$
$$i = 1, 2, \cdots, m\,; j = 1, 2, \cdots, n. \tag{14}$$

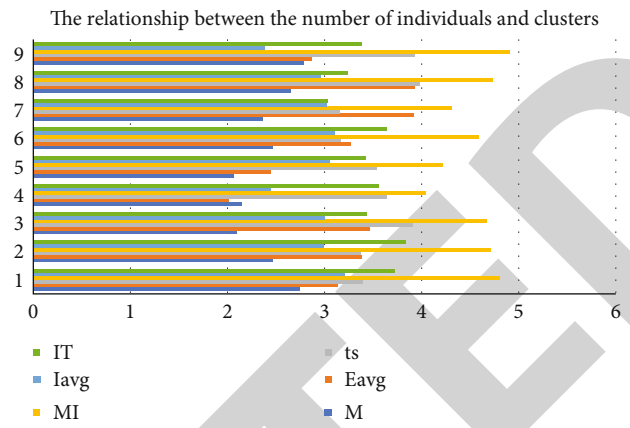

Figure 5: Relationship between the number of individuals and clusters.

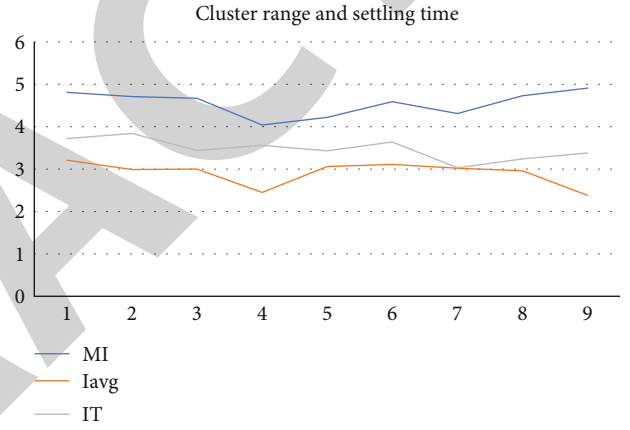

Figure 6: Cluster range and settling time.

Group behavior

$$|t_{kj}| \ge |t_{ij}|,$$
$$1 \le k \le n,$$
$$Z_i = |A^- \cdot T_i| = \sum_{j=1}^{m} A^- \times t_{ij}, \tag{15}$$
$$x^i = \sum_{j=1, j\ne i}^{N} f\left(x^i - x^j\right), i = 1, \cdots, N,$$

where F is the attraction and repulsion function, which determines the interaction between individuals, and y represents the position vector of the individual space, respectively.

$$f(y) = -y\left(a - b\exp\left(-\frac{\|y\|^2}{c}\right)\right). \tag{16}$$

4. Simulation Experiment

4.1. Swarm Algorithm Based on GPU Implementation. With the continuous expansion of the scale of the band, the derived computer platform, computer speed has become

Table 3: Test data result table.

Test port	*D*0	*D*1	*D*2	*D*3	*D*4	*D*5	*D*6	*D*7
Operations	9	5	9	7	7	7	9	10
Correct	5	6	5	6	8	6	8	6
Average	6	7	6	7	6	5	8	7

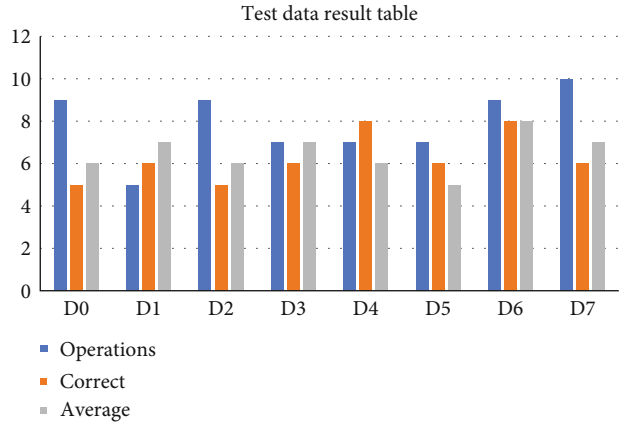

Figure 7: Test data results.

one of the main evaluation indicators of algorithm liquidity. As shown in Table 1 and Figure 4, the initial detection values of CI parameters are S11 = 1.61, S12 = 1.97, S13 = 0.48, S21 = 1.99, S22 = 1.26, S23 = 1.74, S24 = 6, S31 = 9, S32 = 6, and S33 = 10. The emergence of multicore or multicore graphics converters reduces the cost and popularity of high-performance software platforms and provides new platforms and implementation methods for faster computing speeds for applications. Comparing marine biopopulation models relies on the i4Ocean platform. The i4Ocean platform is a computer platform for seascape information and virtual reality applications, including view management, production engine, and MVC core framework. The initial detection values of BIO are *S*11 = 1.43, *S*12 = 1.89, *S*13 = 1.22, *S*21 = 1, *S*22 = 0.64, S23 = 1.14, *S*24 = 6, *S*31 = 10, *S*32 = 10, and *S*33 = 6. The MVC core code of the basic layer combines the basic code and the application layer code, improves the MVC core framework of application development based on platform architecture, and supports GPU accelerated display interface. The i4Ocean platform has ocean data views, as well as 3D seascape simulations, especially seascapes.

4.2. Group Model Based on Individual Rules. The swarm model simulates the movement of fish in a virtual ocean. As shown in Table 2 and Figures 5 and 6, when the quantity value is 2.75, *M* = 2.75, eavg = 3.14, ts = 3.39, MI = 4.81, Iavg = 3.21, and IT = 3.72, determine their behavioral changes based on determined behavioral conditions (e.g., in position, position, and velocity). As everyone in the group moves, the entire group is monitored for behavior. When the quantity value is 2.47, *M* = 2.47, eavg = 3.38, ts = 3.37, MI = 4.71, Iavg = 2.99, IT = 3.84, and the entire group will be monitored for behavior. Since each entity in this model only contains information within the scope of a regional perspective, there is no information on the entire global environment due to local administrative norms. Traditional drawing pipelines process columns and pixels based on a prearranged workspace and then drag graphics onto the screen. The main and main disadvantage of traditional drawing is that the columns of the drawing diagram are inserted into the drawing pipeline, no component can be changed during the whole machining process, and it is not easy. In a traditional recording pipeline, the pipeline receives columns of 3D graphics and then creates the pixels that appear on the screen.

4.3. New Building Intelligent System. Most homes use a management approach based on an access management system. The central level control system includes lighting, fire protection, security, and building equipment systems as the basic system units, and the central station is used to control the operation of various types of systems. As shown in Table 3 and Figure 7, the number of operations is*D*0 = 9 ,*D*1 = 5,*D*2 = 9,*D*3 = 7,*D*4 = 7,*D*5 = 7,*D*6 = 9, and*D*7 = 10. As the scale of different types of controllers and converters in the home increases, so does the human activity of the smart home. The system switching between different systems is difficult, the center reliability is high, and the hardware standards are inconsistent. The average values in the test data are *D*0 = 6, *D*1 = 7, *D*2 = 6, *D*3 = 7, *D*4 = 6, *D*5 = 5, *D*6 = 8, and *D*7 = 7. Smart buildings involve many aspects of the social machine, such as building construction, which not only affects architecture but also design. Smart construction helps improve quality, shorten production time, save resources, and control costs. It is an important part of the structural transformation of the supply side of the construction industry and an important tool for the structural adjustment and modernization of the construction industry and greenhouses.

4.4. Spatial Layout of Intelligent Buildings. Decision space design follows higher architectural standards such as furniture, space, office buildings, and lighting, aiming to provide a comfortable working environment, communication environment, and decision support methods to help decision makers. As shown in Figure 8, the layout of the meeting space will choose quiet spaces, such as those on higher floors, to ensure privacy. The size and exact shape of the meeting space will depend on the number and size of the company's workforce, as well as storage space for equipment used at the event. Designers should take care not to open the windows on the wall behind the meeting seats as much as possible, and decorate them with electrical appliances that can make sounds and block the ball, so as not to be disturbed by the outside world during the meeting. Office space——-The building layout is reasonable, the lighting design is good, and it has the characteristics of safety, health, warmth, and comfort. To ensure safety and hygiene, avoid blind spots of wind pressure and fire prevention, and ensure the efficiency of single-room air separation, attention should be paid to the correct selection of building space and the design of adaptive equipment systems. For mobile office space, a space approach can be adopted. The hybrid space scheme divides the large office into perimeter spaces with exterior

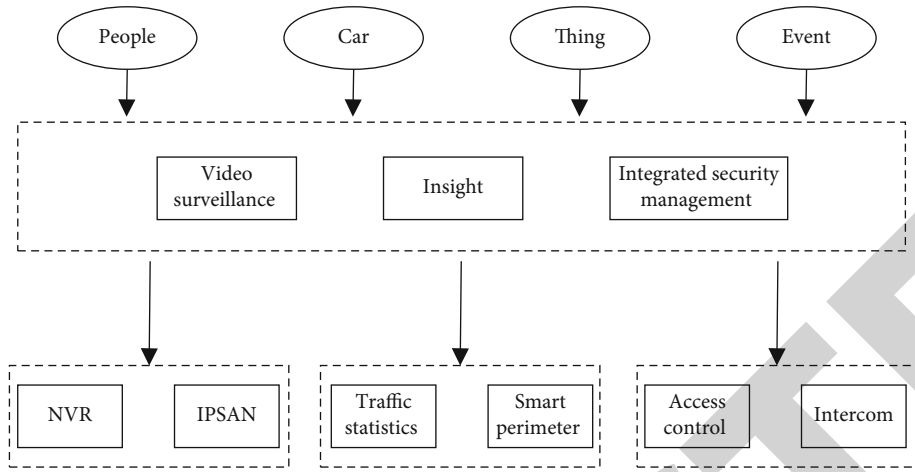

Figure 8: Intelligent building space layout.

Table 4: Optimization strategy results.

Optimization	Difference	Inter-pedestrian	Path length	Progress
Before	0.467	1.349	0.101	0.392
G	0.135	1.442	0.044	0.253
GA+SA	0.058	1.521	0.046	0.303
GA+G	0.069	1.311	0.037	0.272

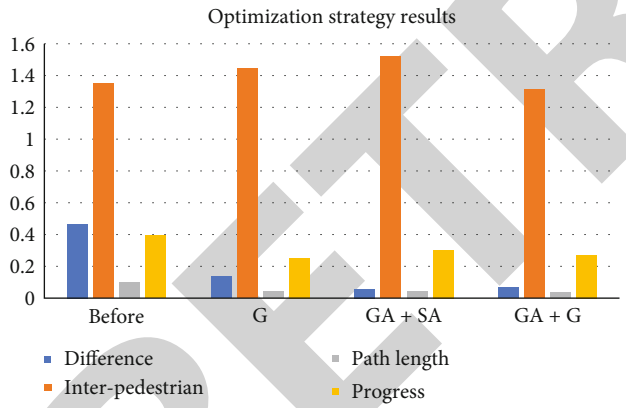

Figure 9: Optimization strategy results.

windows, and uses glass panels to isolate the interior spaces for use as offices. Spaces for secretaries and assistants and open communication spaces improve the office environment by adding decorations.

4.5. Optimization of Intelligent Control System. In BACnet intelligent control, the upper computer monitoring software uses the configuration program to read and monitor with the lower computer, monitor the data returned by each notebook computer, and drive the lower computer to perform similar tasks; the underlying computer communicates with the controller created by the PLC through the BACnet protocol. As shown in Table 4 and Figure 9, the operating system removes and configures the host computer from the computer monitoring system connected to the QT5. X2View is similar to the most popular configuration king with integrated functions. Project software is placed on the X2View and sent to the door or touch screen for processing and monitoring. In the driver configuration interface, you can set the application frame time of the monitoring node and the real-time measurement time of the record value recording time frame. The time of the application frame is set to 2000 ms, and the time of the write value in the start time frame is set to 500 ms. Since the number of monitoring nodes of the operator is 8, four kinds of monitoring nodes are created in the monitoring nodes. Due to the progress of project research and development, some can be prepared. In the future, more monitoring groups can be incorporated to include. The size type and address of the collection point are set in the tool's features.

5. Conclusion

Smart buildings can store various types of data, analyze data at a faster speed, and quickly provide users with the most accurate and high-quality intelligent services through technical means. The main purpose is to meet the needs of users. Provide communication and a series of knowledge services for all professional participants, and provide comfortable working resources and working environment for all professional participants to ensure the smooth implementation of the project and meet the construction engineering requirements. In this study, the spatial layout and optimization of intelligent buildings are carried out based on biological population simulation, and the following conclusions are drawn: (1) The emergence of multicore or multicore graphics converters reduces the cost and popularity of high-performance software platforms and provides faster computing speeds for applications. A new platform and implementation method has been developed. Comparing marine biopopulation models relies on the i4Ocean platform. The i4Ocean platform is a computer platform for seascape information and virtual reality applications, including view management, production engine, and MVC core framework. The

initial detection value of BIO is $S11 = 1.43$, $S12 = 1.89$, $S13 = 1.22$, $S21 = 1$, $S22 = 0.64$, $S23 = 1.14$, $S24 = 6$, $S31 = 10$, $S32 = 10$, and $S33 = 6.2$. The model simulates the movement of fish in a virtual ocean and determines their behavioral changes based on determined behavioral conditions (e.g., in position, position, velocity). As everyone in the group moves, the entire group is monitored for behavior. (3) Intelligent buildings involve many aspects of the social machine, such as building construction, which not only affects architecture, but also design. Smart construction helps improve quality, shorten production time, save resources, and control costs. It is an important part of the structural transformation of the supply side of the construction industry, and an important tool for the structural adjustment and modernization of the construction industry and greenhouses. (4) X2View is similar to the most popular configuration king, with integrated functions. Project software is placed on the X2View and sent to the door or touch screen for processing and monitoring. In the driver configuration interface, you can set the application frame time of the monitoring node and the real-time measurement time of the record value recording time frame.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

Acknowledgments

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Retraction

Retracted: Use Brain-Like Audio Features to Improve Speech Recognition Performance

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] J. Wang, B. Li, and J. Zhang, "Use Brain-Like Audio Features to Improve Speech Recognition Performance," *Journal of Sensors*, vol. 2022, Article ID 6742474, 12 pages, 2022.

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Research Article

Use Brain-Like Audio Features to Improve Speech Recognition Performance

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Speech recognition plays an important role in the field of human-computer interaction through the use of acoustic sensors, but speech recognition is technically difficult, has complex overall logic, relies heavily on neural network algorithms, and has extremely high technical requirements. In speech recognition, feature extraction is the first step in speech recognition for recovering and extracting speech features. Existing methods, such as Meier spectral coefficients (MFCC) and spectrograms, lose a large amount of acoustic information and lack biological interpretability. Then, for example, existing speech self-supervised representation learning methods based on contrast prediction need to construct a large number of negative samples during training, and their learning effects depend on large batches of training, which requires a large amount of computational resources for the problem. Therefore, in this paper, we propose a new feature extraction method, called SHH (spike-H), that resembles the human brain and achieves higher speech recognition rates than previous methods. The features extracted using the proposed model are subsequently fed into the classification model. We propose a novel parallel CRNN model with an attention mechanism that considers both temporal and spatial features. Experimental results show that the proposed CRNN achieves an accuracy of 94.8% on the Aurora dataset. In addition, audio similarity experiments show that SHH can better distinguish audio features. In addition, the ablation experiments show that SHH is applicable to digital speech recognition.

1. Introduction

Speech recognition, which enables acoustic sensors for human-machine dialogue, is an important technology in the field of human-computer interaction, and it mainly consists of feature extraction and model fitting. Audio features simplify the signal sampled from the original waveform, thus speeding up the understanding of audio semantics by machines [1]. Commonly used feature extraction methods include Fast Fourier Transform (FFT), Short-Time Fourier Transform, Wavelet Transform, and Mel-filter bank. The results of audio feature extraction are available in various forms, such as spectrum, spectrogram, wavelet coefficients, Mel spectrogram, and Mel-filter coefficients (MFCC). Feature extraction methods are widely used in various audio tasks but are still limited to the transformation of the spectrum and the fitting of functions; this leads to a large loss of acoustic information and a lack of biointerpretability [2]. The audio processing method proposed in this study for performing speech recognition is based on audio processing in the human brain.

Calvo-Gómez et al. used spike pulses to accurately encode the temporal location and size of audio features [3]. They used gammatones to decompose the audio signal and obtain spike maps. Gammatones are mathematical approximations of cochlear filters [4]. Spike maps provide better reproduction of audio features because they avoid blocking artifacts and temporal frequency trade-offs associated with conventional spectrogram representations. In response to the problem that existing speech self-supervised representation learning methods based on contrast prediction need to construct a large number of negative samples during training

and their learning effects depend on large batches of training, which require a large amount of computational resources, a method using only positive samples for speech contrast learning is proposed and combined with a masking reconstruction task to obtain a multitask self-supervised speech representation learning method, which reduces the training complexity while reducing the training complexity and improving the performance of speech representation learning [5]. Among them, the positive-sample contrast learning task, borrowing ideas from the SimSiam method in image self-supervised representation learning, uses a twin network architecture to perform two data enhancements on the original speech signal with the same encoder, passing one branch through a forward network and the other branch using a gradient stopping strategy to adjust the model parameters to maximize the similarity of the outputs of the 2 branches [6]. The entire training process does not require the construction of negative samples and can be performed using small batches, which substantially improves the learning efficiency. Using the LibriSpeech corpus for self-supervised representation learning and fine-tuning tests in a variety of downstream tasks, comparative experiments show that the representation model obtained by the new method meets or exceeds the performance of existing mainstream speech representation learning models in several tasks [7].

Inspired by biological neurons, spiking neuron networks (SNNs) are very popular in deep learning (DL). As a widely used neuronal model in SNNs, the Hodgkin-Huxley (HH) model describes the electrical behavior of giant squid axon membranes, and some biological spiking neuron models are based on it [8]. To solve the problem of computationally overloaded HH neuron model, leaky integrate-firing (LIF), regular spikes (RS, also called Izhikevich model), and other neuron models have been proposed. In the HH model, there are three ionic currents in the membrane: sodium ion current, potassium ion current, and leakage current. A set of ordinary differential equations can be used to model the dynamics of the cell membrane potential. When the potential reaches a certain value, a pulse is generated. We obtained audio features by feeding the spike maps into the HH model for further processing and used the output audio pulse sequence features for subsequent processing [9].

In previous work, support vector machines (SVMs) and convolutional neural networks (CNNs) were used as classifiers after processing audio signals using SNNs [10]. We refer to common DL methods used in speech recognition and try to design a better network structure. CNNs and recurrent neural networks (RNNs) are widely used for speech recognition. CNNs can efficiently analyze and process input spectrograms and are suitable for processing spatial features, while RNNs can efficiently analyze time series data and are suitable for processing temporal features [11]. Therefore, the combination of these two methods is advantageous. The RNN layer is generally connected in series after the CNN layer. However, in this study, features are fed into the CNN and RNN in parallel and their outputs are combined so that both temporal and spatial features can be considered [12].

The main contributions of this study can be summarized as follows: (1) we propose SHH, a feature extraction method that combines spikegram and HH models, which perform audio signal processing like the cochlea and neuron, respectively. We extracted spikegrams from the audio signal instead of transforming them spectrally. The spike maps were processed using the HH neuron model, and the number of pulses was used as an audio feature. Dynamic time warping (DTW) experiments and ablation experiments were performed on the Aurora dataset to demonstrate the efficiency of our method. (2) We propose a parallel CRNN for training and testing. Features are fed to ResCNN and BRNN blocks and stitched at the output to better accomplish the analysis from temporal and spatial perspectives. The network achieved an accuracy of 94.8% on the Aurora dataset, which is better than the accuracy obtained using other models [13].

The rest of the paper is divided into the following sections. In Section 2, the study that inspired us is summarized. In Section 3, the proposed method is described, including spikegram, HH features, and CRNN. In Section 4, the experimental results are presented, the results are discussed, and a comparison with previous work is made. Finally, conclusions are presented in Section 5.

2. Research Background

2.1. Brain-Like Audio Feature Extraction Methods. Recent research has focused on brain-like audio feature extraction methods. A two-layer probabilistic model was developed by Vaishnavi et al. A two-layer probabilistic generative model based on spike maps was developed for complex acoustic structures. Spike maps are not suitable for standard classification methods such as multilayer perceptrons (MLPs), which usually require normalized vectors as input data [14]. Li et al. proposed a data representation method to solve this problem and make it applicable to MLP classifiers. Spikegrams have been commonly used for audio tasks, such as audio watermarking, music genre classification, and automatic instrument recognition [15].

SNNs have been used for speech recognition. Neuronal models such as LIF, RS, and HH have been used to process audio signals and applied to speech classification tasks. Xu and Cox compared the biological interpretability and implementation cost of various impulse neuron models [16]. The LIF and RS models are one-dimensional (1D) neuron models with low computational cost but poor biointerpretability compared to the HH model; therefore, we chose the HH model. In future studies, we will compare these neuronal models in detail.

2.2. Attention Mechanism. Some researchers have conducted relevant studies for the future unmanned system intelligence and the development needs of multiunmanned system cooperative perception and cognition to solve the scientific problems of information overload and crossplatform multisource perceptual information fusion and proposed to explore the mechanism of multisource attention mechanism on the regulation of unmanned system intelligent perceptual system by

studying the mechanism of the regulation of bionic endogenous and exogenous attention and the mechanism of its mapping heterogeneous multisource perceptron. Combined with the ability of brain cognition to combine cues from different sensory channels to achieve fast and efficient information filtering and heterogeneous multi-source cognition of objects and events in the external world and the use of different reference systems to characterize the features and locations of objects, an intelligent perception and information processing framework based on bionic multisource attention mechanism is constructed, which is useful for engineering the implementation of intelligent perception, cognitive system, and attention mechanism of unmanned systems. The design reference value for engineering the intelligent perception, cognitive system, and attention mechanism of unmanned systems is certain. It has greater significance to this paper [17].

Another scholar proposed an improved graph attention (GAR) mechanism model for the problem that a large amount of feature information is easily lost in the process of learning graph embedding node representation and its incomplete graph topology retention in graph neural network model. The model is divided into two parts: node-level bidirectional attention mechanism and graph-level self-attentive graph pooling. Firstly, in the process of learning new feature vector representations of graph nodes, a bidirectional graph attention weight is adopted to provide a reliable choice for neighborhood node retention while enhancing the similarity properties among nodes; secondly, a graph embedding representation is generated at the pooling layer by using node feature vectors as inputs in the overall topology of the graph in conjunction with a self-attention graph pool and by paying attention to the self-attention weights provided by the convolution layer; finally, the model is tested on Cora, Citeseer, and PubMed datasets, and the experimental results show that compared with the baseline graph attention mechanism model, the improved model can fully consider the local and overall structural features of the graph, effectively enhance the model's ability to aggregate neighborhood information, reduce the loss of original features in the graph embedding process, and significantly improve the performance of the model in downstream tasks. It provides some help for the study of this paper [18].

The DL attention mechanism involved in this paper is based on the visual attention mechanism of the human brain. Wang et al. [19] combined RNN with attention mechanism and applied it to computer vision. Yang et al. [20] implemented the attention mechanism in audio processing and proposed a parallel attention framework. Efficient Channel Attention (ECA) replaces the two convolutions in the squeeze and excitation network with a more efficient connection method that improves accuracy, reduces the number of parameters, and yields accurate channel weights and attention information; the audio signal is split into multiple channels by using filters. We use the ECA module to obtain more reliable attention information and to allocate computational resources more rationally.

2.3. Speech Recognition Model. Some scholars have studied language recognition models and found that speech recognition systems often have recognition errors when the audio quality is poor. To improve recognition accuracy, we design an English translation robot speech recognition system based on a continuous hidden Markov model. In the hardware, the audio signal receiver and the main processor of the robot audio recognition module are designed. In the software, quantize the audio signal and preemphasize the processing, calculate the ratio between the frame shift distance and the length of each frame, obtain the analog signal conversion frequency and the basic unit quantization index, construct the speech text decoder based on the continuous hidden Markov model, calculate the width of the window function, obtain the Markov chain probability path in the grid, compare the complexity of different probability paths, design the English translation robot speech recognition algorithm, and get the speech recognition results of English translation robot. From the experimental data, it can be seen that the speech recognition accuracy of this system is above 75% under three different audio qualities, which is more stable than other systems, and the accuracy is higher under the same audio quality, which shows that the speech recognition system with the continuous hidden Markov model is better than other systems [21].

The DLs involved in this study have been successfully applied to automatic speech recognition (ASR). CNNs are suitable for acoustic modeling because they consider the structural localization in the feature space. CNNs have been used for end-to-end speech recognition. By increasing the number of layers in a CNN, the recognition accuracy can be improved. End-to-end ASR models have been developed using 1D convolution, batch normalization, ReLU, dropout, and residual join in Jasper model, replacing acoustic and articulation models with CNNs.

RNNs are suitable for processing time series data. Long Short-Time Memory (LSTM) is a type of RNN that can better solve the gradient disappearance and gradient explosion problems in long sequence training. Yu et al. [22] extended the deep LSTM RNN and achieved excellent performance in long-range speech recognition tasks. Sailaja et al. used LSTM-RNN as a classification model to process features extracted using MFCC and spectral and logarithmic spectrum [23].

The combination of CNN and RNN can better handle speech tasks because it integrates the temporal and spatial features of the speech signal. Shi et al. [24] used CRNN to solve the scene text recognition problem. After extracting image features using CNN, RNN was used to predict the sequence. The final result is obtained from the CTC translation layer. This structure was used for speech recognition by Yu et al. [25] by replacing the LSTM with a convolutional LSTM. In end-to-end speech recognition tasks, CNN and RNN are used as encoder and decoder, respectively. In this study, we combine CNN and RNN in parallel, instead of the serial structure used in previous studies, to take into account the temporal and spatial characteristics of audio features. In addition, most of the previous work used MFCC and spectrograms, while we used an audio feature extraction method that performs audio processing like a human brain.

3. Materials and Methods

In this section, we describe our method in detail. The work includes feature extraction based on spike maps and HH models.

3.1. Dataset Processing. The experiments are conducted on the Aurora dataset. Aurora is part of the Tidigits dataset, which includes both adult and child voices. Aurora takes out the adult part of Tidigits at a sampling rate of 16 kHz. Using the Hamming window, all the audio is divided into N frames with 40% overlap to support frame lengths of 0.1-0.25 ms, and N is positively correlated with the length of the audio.

3.2. Spike Map. In the peripheral auditory system, incoming sound signals are mechanically transmitted to the inner ear, undergo a highly complex transformation, and are then encoded by spikes in the auditory nerve. The audio signal is encoded using a set of kernel functions by Smith et al.

$$x(t) = \sum s_i^m \varphi_m(t - \tau_i^m) + \varepsilon(t), \tag{1}$$

where $\varepsilon(t)$ denotes Gaussian white noise, τ_i^m and s_i^m are the time position and coefficients of the ith instance of the kernel function, $\boldsymbol{\varphi}_{\mathbf{m}}$, respectively. The superscript m or subscript represents the type of kernel function. We choose gammatone as the kernel function to decompose the sound signal, denoted as $\varphi(t)$.

$$\varphi(t) = ct^{n-1} e^{-2\pi bt} \cos(2\pi f t + \theta), \tag{2}$$

where$c$is the scale factor, n is the filter border, is the time decay coefficient, f is the filter center frequency, and θ is the filter phase. The spectrogram is a traditional time-frequency visualization, but it actually has some important differences from the way the ear analyzes sound; most importantly, the frequency subbands of the ear widen for higher frequencies, while the spectrogram has a constant bandwidth over all frequency channels.

However, this is a rather expensive calculation. D.P.W. Ellis offers an alternative algorithm which gives very similar results and calculates the time-frequency distribution about 30-40 times faster than the full method. The result is $16 * N$, where 16 stands for the number of kernels and N for the time period.

The acoustic signal can be most efficiently encoded by decomposing discrete acoustic signal cells; each cell has an exact amplitude and temporal location. Smith et al. used the matched pursuit algorithm to compute the acoustic signal. The matched pursuit algorithm is used to calculate τ_i^m and the s_i^m value of the sum, iteratively approaching the input signal to determine the best solution for encoding. The resulting spike map consists of three dimensions: time, center frequency, and amplitude. The X-axis represents time, the Y-axis represents the central frequency, and the size of the circles represents the amplitude. The feature vectors containing these three dimensions are fed into the HH model.

3.3. HH Model. We use the HH model to calculate the number of spikes. There are three types of ionic currents in the membrane: sodium current, potassium current, and leakage current. The total current through the cell membrane can be calculated as follows:

$$I = C_M \frac{dV}{dt} + \bar{g}_K n^4 (V - V_K) + \bar{g}_{Na} m^4 h (V - V_{Na}) + \bar{g}_L (V - V_L), \tag{3}$$

where $\bar{g}_{\text{ion}}$ represents the maximum conductivity of ions, C_M represents the membrane capacity, and V is the displacement of the membrane potential from its resting value. m, n, and h are the intramodel variables associated with the ion channels; their differential equations are as follows:

$$\begin{aligned} \frac{dn}{dt} &= \alpha_n(V)(1 - n) - \beta_n(V)n, \\ \frac{dm}{dt} &= \alpha_m(V)(1 - m) - \beta_m(V)m, \\ \frac{dh}{dt} &= \alpha_h(V)(1 - h) - \beta_h(V)h, \end{aligned} \tag{4}$$

whereα_n, α_m, α_h, β_n, β_m, and $\beta_h$are the equations related to V functions related to

$$\begin{aligned} \alpha_n(V) &= \frac{0.01(V + 55)}{1 - e^{-(V+55)/10}}, \\ \alpha_m(V) &= \frac{0.1(V + 40)}{1 - e^{-(V+40)/10}}, \\ \alpha_h(V) &= 0.07e^{-(V+65)/20}, \\ \beta_n(V) &= 0.125e^{-(V+65)/80}, \\ \beta_m(V) &= 4e^{-(V+65)/18}, \\ \beta_m(V) &= 4e^{-(V+65)/18}. \end{aligned} \tag{5}$$

Equation (6) is obtained by solving equation (3) using Euler's method. Equation (3) is obtained by using Euler's method.

$$\frac{dV}{dt} = -\frac{1}{C_M} \left[\bar{g}_K n^4 (V - V_K) + \bar{g}_{Na} m^4 h (V - V_{Na}) + \bar{g}_L (V - V_L) + I\right]. \tag{6}$$

First, the initial values of the variables are set and the value of the parameter $\bar{g}_L$ is 0.3; the value of the $\bar{g}_K$ parameter is 36; the value of $\bar{g}_{Na}$ the parameter is 120; the value E_L of the parameter is -54.5; the E_K value of the parameter is -77; the value of the parameter E_{Na} is 50; the value of the parameter C_M is 1; and the value of the parameter V_0 is -70. $E_{\text{ion}}$is the equilibrium potential of the ion, V_0, which is the resting potential. The value of the current is obtained from the central frequency and the scale. We directly use the amplitude as the magnitude of the current. For each kernel, traversing each time window, the current values are entered into the HH model for 50 ms, divided into 5,000 time steps of 0.01 ms.

We use equation (7) to update the variables for each time step and then calculate the voltage value for the current time step to obtain an approximate $V(t)$ function. A pulse is generated when the voltage is greater than the maximum value obtained at the previous and the next time step. The relationship between voltage and time is described in detail in this paper.

$$V+ = \text{step} * \left(-\frac{1}{C_M} \left(\bar{g}_K n^4 (V - V_K) + \bar{g}_{Na} m^4 h (V - V_{Na}) + \bar{g}_L (V - V_L) + I \right) \right). \tag{7}$$

We count the spikes for each segment and then repeat the above operation for each kernel. The final features are obtained. These features are fed into the CRNN model, which will be discussed in Section 3.4.

3.4. CRNN Model Structure. In the proposed CRNN model, CNN is applied to spatial data and RNN is applied to sequential data. CRNN consists of two parts: a ResCNN block and a BRNN block. Features are fed into these two blocks, which can efficiently process both spatial and temporal feature information. For ease of expression, the convolution is abbreviated as Conv and the batch normalization is abbreviated as BN.

An ECA layer is set before the ResCNN block. The ECA obtains accurate channel weights and attention information by aggregating the information of each channel on a one-dimensional convolutional layer. After the ECA layer, the next ResCNN block can focus on the more effective channels.

The ResCNN block has two channels. The network on the right side consists of three convolutional layers and a pooling layer. We treat Conv + BN + ReLU as a single layer. The first layer is a convolutional layer of size (1, 1, 0), which makes the output have the same size as the input. This convolution has a kernel size of 1, a padding of 0, and a span of 1. The second and third layers are convolutional layers of sizes (3, 1, 0) and (1, 1, 0), respectively. The subsequent layer is the maximal ensemble layer, where the feature map is reduced by half.

The network on the left contains only one convolutional layer of size (3, 1, 1), thus keeping the image size constant. The final output of ResCNN is obtained by summing the outputs of the two pathways.

The proposed BRNN model includes two bidirectional RNN layers with LSTM units. The BRNN combines two RNNs, one moving forward from the beginning to the end of the sequence and the other moving backward to obtain the complete past and future background information of each point in the input sequence. We use LSTM because it overcomes the drawbacks of RNNs, such as long-term dependence and gradient disappearance.

Finally, the outputs of ResCNN and BRN are combined and fed to the fully connected layer. The SoftMax function reflects the weights in the fully connected layer with probability values between 0 and 1.

3.5. Neural Networks. Other kinds of algorithms require relevant mathematical mapping relations. The artificial neural network algorithm involved in this paper does not require a large number of mathematical mapping relations, so it does not need to input a large number of mathematical equations in the first place, because it needs to be able to learn some other basic mathematical rules systematically by training the data in advance, so that it can output the required mathematical calculation results and simulate the mathematical model better given certain function values and mathematical function values. As a complex discipline in computer science and mathematics and statistics, one of the main core functions of artificial neural network is to train algorithms for mathematical calculations and information statistics.

The basic algorithm theory BP algorithm theory process mainly includes the output signal deviation forward and backward linear propagation process calculation and the output signal error forward and backward linear propagation process which are two process calculation process. That is, the signal error can be adjusted according to the two input directions from the actual input signal direction to the actual expected signal output, respectively, to calculate the signal output, from the direction of the real expected signal output and then to the real expected input direction of the two directions, respectively, and to calculate the signal error to adjust the signal error weight range and error threshold. In the study of the propagation method after the forward superposition of the signal, the input node signal is mainly the node on the actual output of the signal after the inverse superposition through the role of the hidden layer, and the actual output node signal can be generated through the nonlinear transformation process. If we find that the actual signal output node position is not consistent with the actual input node expectation signal of the actual output node direction position, it will be easy to produce the process of backward feed-back propagation method for signal error compensation. The principle of error input signal back propagation processing system is that the system will automatically back propagate its various output signals or error information values to each error input layer of the system through the hidden layer nodes layer by layer and will sequentially transfer its output error signal value distribution to the nodes on each layer corresponding to all other layers of the system error input signal elements, with the system in each layer of the system nodes obtained. The output error input signal values obtained by the system at each layer node are used as the basis for its calculation to automatically adjust the weights of the system's error output signal elements.

4. Results and Discussion

4.1. Neural Network Research. A neural network is essentially a nonlinear predictive model that, like its name, is an algorithm that imitates the human and animal nervous systems for computation. It is based on imitating the human and animal brain neural network system to perform the computation and then to process the content of each

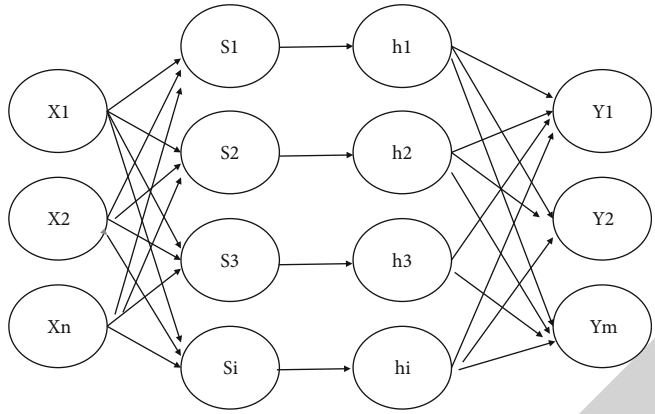

Figure 1: Wavelet neural network.

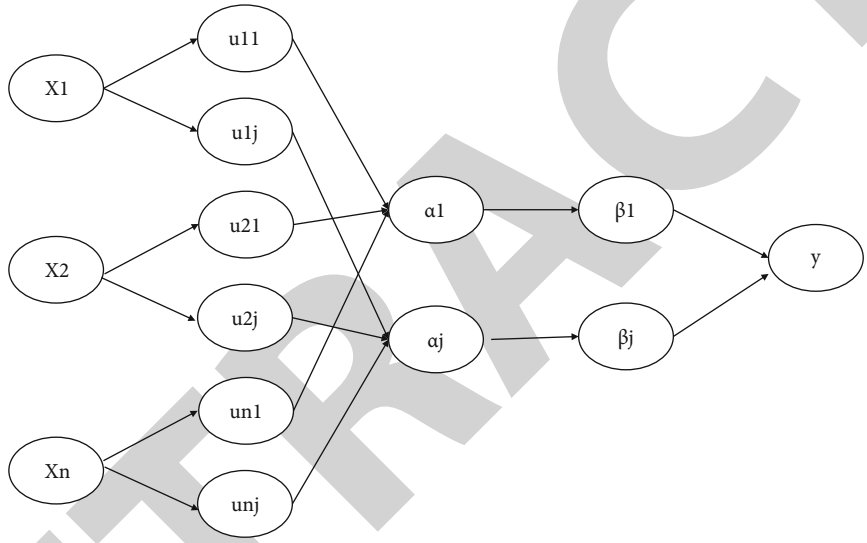

Figure 2: Fuzzy neural network.

module. Neural network algorithm is a derivative of data mining technology, which is one of the types of data mining technology that can be used for big data mining, such as analysis, classification, aggregation, and other data mining functions. Its advantages and disadvantages are very clear; the first advantage is that it is extremely resistant to interference, and the second is that it is capable of deep learning and better memory in a nonlinear situation and can handle more complex situations. At the same time, it has two disadvantages. First, its computation and processing results are low-dimensional and cannot be adapted to a high-dimensional environment, so it has a hard-to-interpret nature. The second is that both supervised learning and unsupervised learning require a long learning time and data collection using more traditional neural network methods.

The main first of all utilized in this paper is wavelet neural networks, and such neural networks process data from two main parts of the algorithm. These two types of algorithms are the effective supervised learning and the ineffective unsupervised learning that are common in algorithms. In the latter part, the data are first analyzed by clustering through certain algorithms to obtain the central part of the hidden neural network, and then, the results of this step are used to perform calculations to figure out the value of the width of the number. The wavelet neural network is shown in Figure 1.

Next is the fuzzy neural network. This type of neural network (FNN for short) begins with a deep combination of fuzzy theory and neural network algorithms. In the process of data mining and information processing by neural network algorithms, fuzzy theory is incorporated to improve the mapping and the relevance of mathematical relations. The efficiency of supervised learning and unsupervised learning is better improved. The algorithmic formulas of such neural networks and the related structural diagrams are more commonly used and common and can be found in general textbooks. This kind of neural network is shown in the figure; it goes through five levels in the process of training and supervised and unsupervised learning, at the beginning of the two levels; as the level increases, the range of calculations required will double, but as it enters the third level and enters the fourth level and enters the fifth level, the

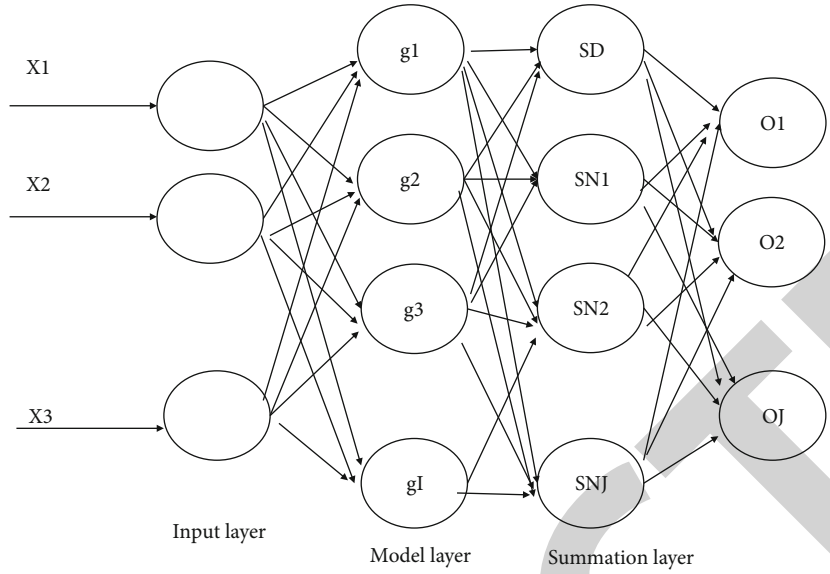

Figure 3: Generalized regression neural network.

content of calculations will gradually decrease until it becomes one. Of course, this type of graph is first tested for dimensionality at this node in the input layer when the input is made. The specific value assumes that the dimension value is n and the node that needs to be input is n. Depending on the number of nodes needed, it is passed all the way to the layer of the dimensionality function and the related layer of functions for further computation, as well as finally to the output layer. This type of fuzzy theory combined neural network has the same nature as the wavelet neural network and the neural network combined with generalized theory, which both use the traditional gradient form of computation downward to calculate the centroid of the affiliation and the associated required width value and the final output value and the weights we need. This is shown in Figure 2.

Again, the generalized regression neural network generalized regression neural network (GRNN) is a four-layer forward propagation neural network with fewer parameters and better nonlinear mapping capability in its network structure. The difference between this neural network and other neural network algorithms is that there is no supervised learning and unsupervised learning data input and training process. The training results are obtained by optimizing the relevant factors in the second layer. It does not have a specific computational process like other types of neural networks but has a specific supervised and unsupervised learning data processing process and training process. The computational process is not shown in detail here, and the specific computational process can be obtained by the radial basis neural network inference, which will not be done in this example. Although this kind of neural network combined with the generalized theory, it does not require supervised and unsupervised learning training, but its second layer, that is, its mode layer, is prone to the phenomenon of violation of statistical laws; firstly, it is very easy to cause the phenomenon of underfitting and not easy to fit, and secondly, the relevant factors in his will appear random wandering phenomenon, so it is more troublesome, as shown in Figure 3.

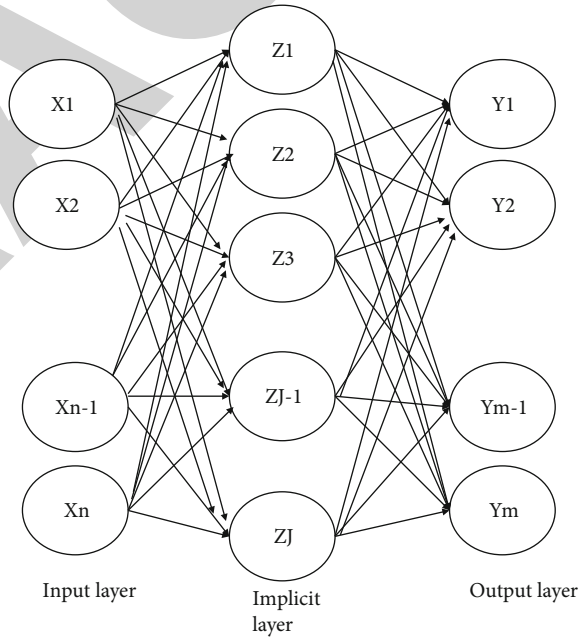

Figure 4: Structure of the radial basis neural network.

Finally, radial basis neural network (RBFNN for short) is one of the most typical radial basis theories combined with the depth of the three levels of the second which is a forward neural network algorithm structure; in addition, the same as the traditional neural network with supervised learning and unsupervised learning of the data training, it is mainly only three layers which is more convenient. Secondly, it has a better statistical basis, it is a linear computation, and then, it can pass to the next layer after data processing by function. After three layers of computation, the output results are obtained.

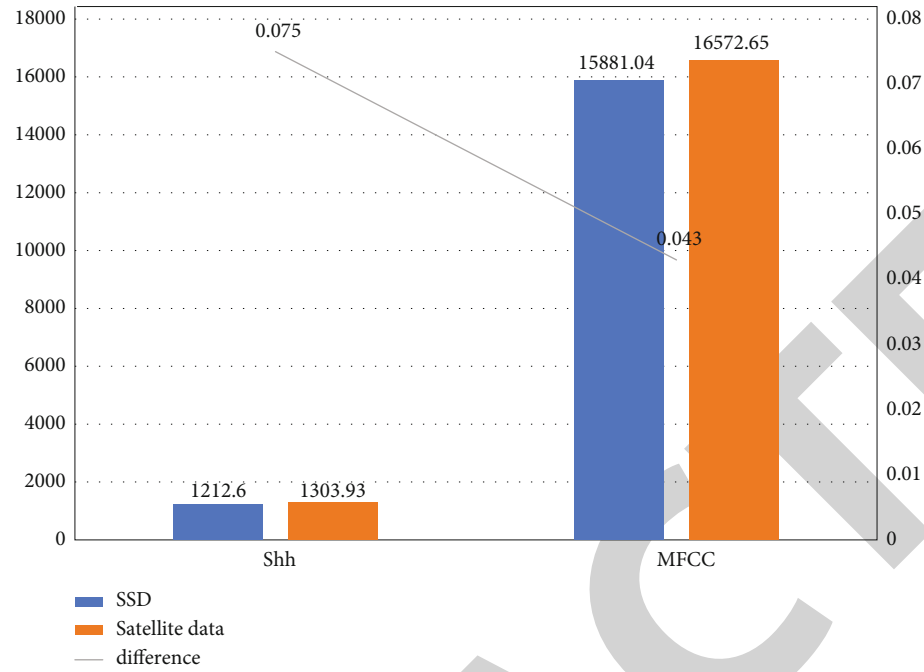

Figure 5: Average DTW distance (SSD) for each speech digit and average DTW distance (SDD) between every two different speech digits and the difference between DTW distance for different audios and the same audio.

In the case of camera neural network, it outputs data mainly through two layers of algorithms; the specific computation is supervised learning and unsupervised learning, respectively. In the supervised learning area, it needs to perform clustering algorithm and analysis of some relevant data for clustering to calculate the required width value and the required neural network result. The radial basis neural network is shown in Figure 4.

4.2. Experiments and Results

4.2.1. Audio Similarity Experiments. First, speech isolated word recognition is achieved by calculating the similarity between speech and matched audio signals. The audio similarity between the same and different speech signals is calculated to determine whether audio features can be used to distinguish them. DTW is a commonly used speech matching algorithm to calculate the similarity between two vectors of different dimensions. The performance of DTW as an early metric learning method is determined by the input features.

The proposed algorithm matches two speech vector sums with different m_1-dimensional m_2 degrees. Each m_1-dimensional m_2 degree of the sum is also a vector that is a feature value for each time period in the speech signal. In this study, we calculated the DTW distance between two transposed SHH features and performed the same operation on MFCC features for comparison. The DTW distance indicates the similarity of the audio.

We selected 50 audios for each digit from the Aurora dataset and extracted their SHH and MFCC features. The average similarity of audio was calculated for the same digit (SSD) and different digits (SDD). The difference between the SSD and SDD values can be used to determine if the DTW algorithm can distinguish these features well.

For audio with the same digits, the feature vectors for all audio are computed in pairs to determine the average DTW distance for each digit. The SSD is the average result of ten digits.

For audio of two different digits, all audio features of both digits are mapped one by one to calculate the DTW distance. We average the results of 2500 calculations to obtain the average DTW distance between each pair of digits. The SDD is the average of the results for 45 digit pairs. This is shown in Figure 5.

The authors also list the average SSD, the average SDD, and the differences, as shown in Figure 6.

SHH features are more concise than MFCC. For the same audio signal, the DTW distance of SHH features is much smaller than that of MFCC, while the difference of DTW distance is relatively more obvious for different audio signals.

The degree of audio similarity reflected by SHH is very similar to that perceived by the human ear. An audio that sounds very similar to the human ear has a high degree of similarity in SHH features, but MFCC features vary greatly. The differences in SHH features are even more pronounced for an audio that sounds very different to the human ear.

Therefore, feature extraction using SHH is similar to audio processing in the human brain and can better distinguish audio features; therefore, they perform better in speech classification and isolated word recognition.

4.2.2. CRNN Model Testing and Ablation Experiments. To demonstrate the role of each module in the proposed

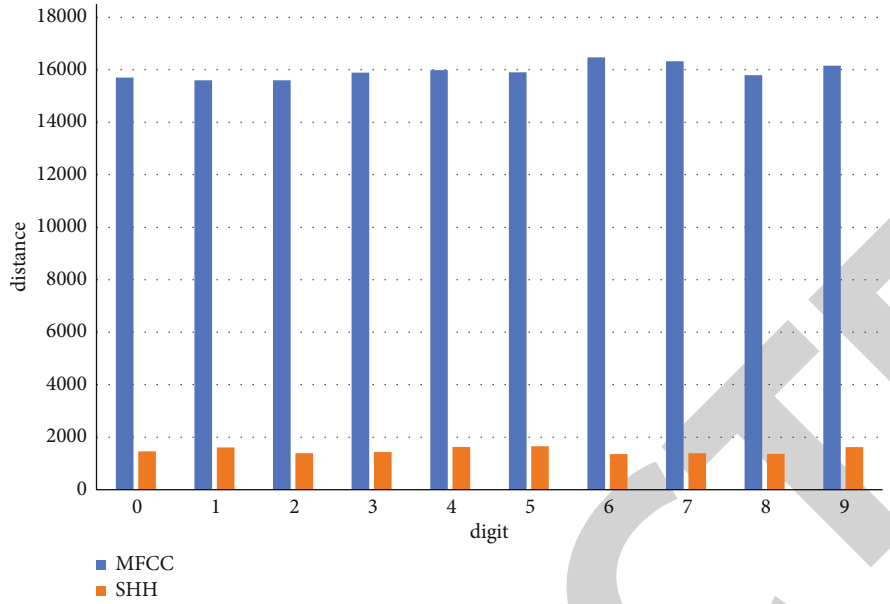

Figure 6: Average DTW distance for 10 digital voice audio signals.

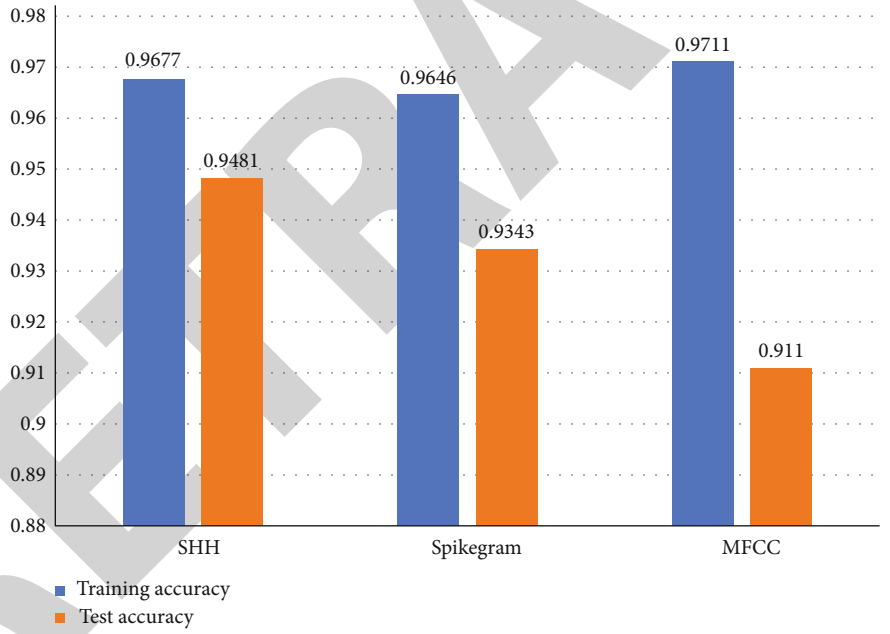

Figure 7: Accuracy of the model using different feature extraction methods.

human brain-like feature extraction method, we designed ablation experiments. In Experiment 1, spikegram and HH modules were used. In Experiment 2, only spikegram features were fed into the CRNN model to demonstrate the validity of the HH model. In Experiment 3, the spikegram and HH modules were not used; instead, MFCC features were extracted to demonstrate the superiority of the proposed method. All three experiments were conducted on the same dataset and used the same training parameters. The dataset was divided into 80% of the data for training and 20% for testing. The learning rate of the neural network was initially set to 0.001, with adaptive updates every 40 calendar hours. The number of training epochs was 1000. Figure 7 shows the training and testing accuracy of the model using three different feature extraction methods. This is shown in Figure 7.

The article also lists the performance of the models in terms of accuracy (P), recall (R), and f1 score (F1) on the SHH method. For P/R/F1, the larger the better; the best results are shown in bold. This is shown in Figure 8.

The performance of the model on the spikegram method in terms of precision (P), recall (R), and f1 score (F1) is

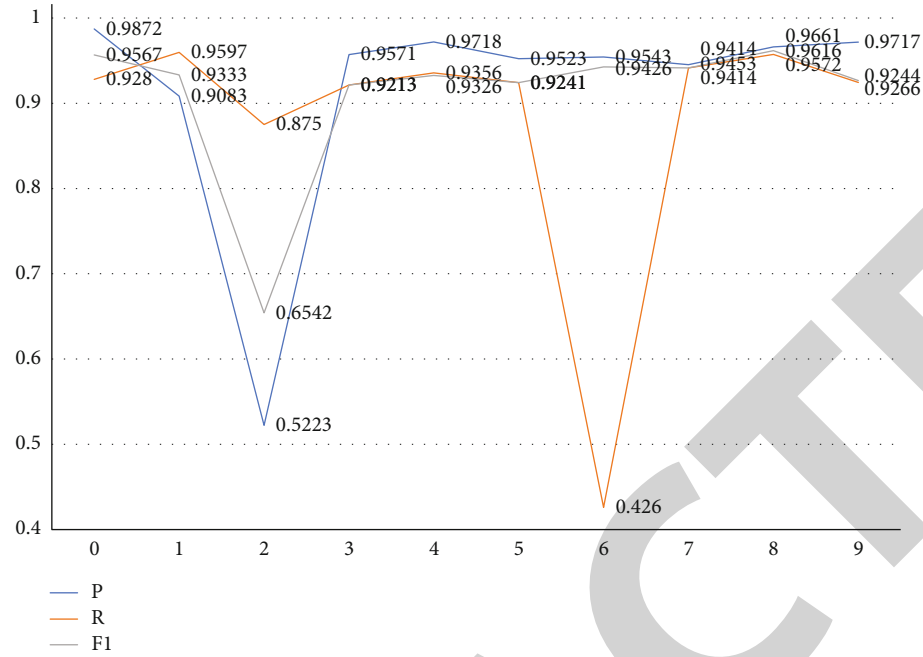

Figure 8: Performance of the model on SHH method in terms of precision (P), recall (R), and f1 score (F1).

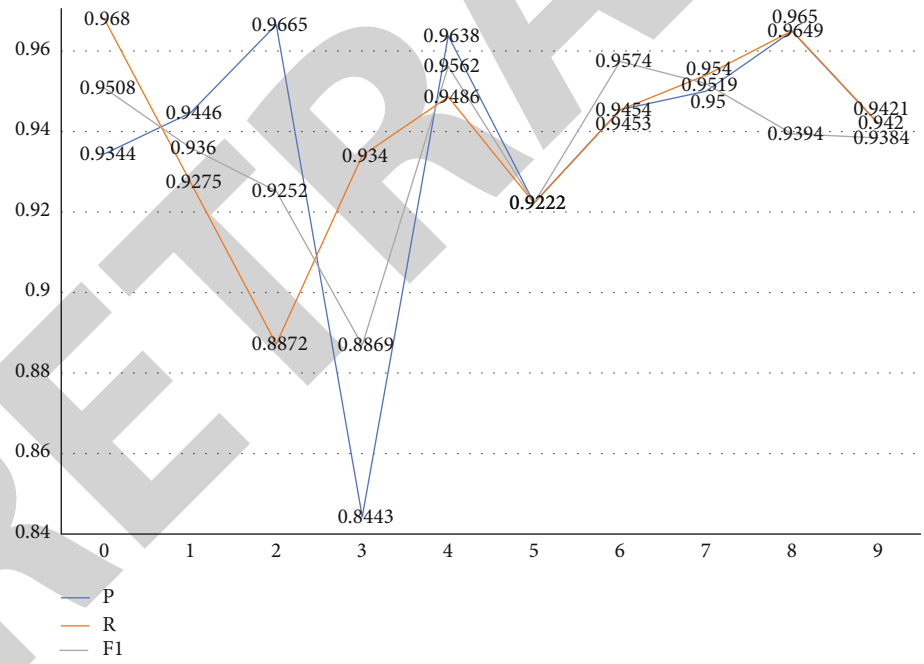

Figure 9: Performance of the model on spikegram method in terms of precision (P), recall (R), and f1 score (F1).

presented. For P/R/F1, the larger the better; the best results are shown in bold. This is shown in Figure 9.

The performance of the model on the MFCC method in terms of precision (P), recall (R), and f1 score (F1) is presented. For P/R/F1, the larger the better; the best results are shown in bold. This is shown in Figure 10.

Three feature extraction methods were used for the experiments: SHH, spikegram, and MFCC. The ablation experiments demonstrate the superiority of the proposed methods. MFCC exhibits superior overfitting performance over spikegram and HH features in a given classification model. In addition, the features extracted using our method have smaller sizes, which may contribute to the generalization ability of the classification model.

4.3. Discussion. The performance of the proposed model in digital speech recognition tasks is compared with the performance of other recent models. Tavanaei et al. proposed a

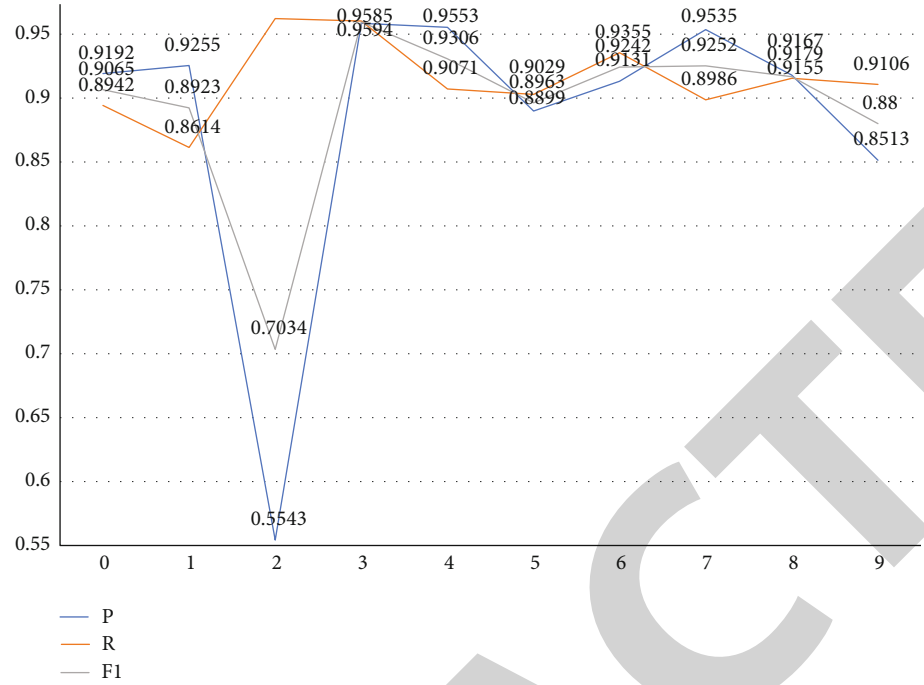

Figure 10: Performance of the model on MFCC method in terms of precision (P), recall (R), and f1 score (F1).

Table 1: Comparison with other models in terms of feature extraction method, classification model, and accuracy in the same task.

Method	Features	Classification method	Accuracy
Tavanaei and Maida [26]	FFT + RS	SVM	91%
Watt and Kostylev [27]	MFCC	SVM + KNN	97.5%
Zada and Ullah [28]	MFCC	CNN	84.17%
Rakshith et al. [7]	MFCC	VQ	93%
Proposed method	Spike map	Speech recognition network (CRNN)	93.43%
	SHH	CRNN	94.8%

nonrecursive SNN to convert speech signals into spike sequence features; they extracted the minimum feature vector from each frame of the spectrum after FFT and used the RS model to convert audio signals into spike sequences. Srinivas et al. used SVM and K-nearest to perform English numeric classification using SVM and K-nearest-neighbor (KNN) classifiers and ensemble methods, i.e., random forests; MFCC features were obtained for all input instances. Zada et al. developed an isolated digit recognition for Pashto language by using deep CNN. In another study, 20 MFCC features were extracted for each isolated digit and input to the CNN; for spoken digit corpus data, MFCC showed better performance than cepstral features. In addition, vector quantization feature matching technique and light gradient boosting machine (LightGBM) were used for feature vector clustering.

SHH was used in Experiment 1 and obtained an accuracy of 94.8% on the test set, which is higher than the accuracy using existing models. In addition, our method uses fewer layers of neuronal networks. This is shown in Table 1

5. Conclusion

In this study, we proposed a new feature extraction method, called SHH, for processing speech audio, which combines spike maps and HH models. In SHH, the spike maps are extracted in a manner similar to the way the human ear processes sound, while the HH model simulates the generation of neuronal impulses. The proposed method has good biological interpretability and can extract more accurate audio features. This audio feature extraction method can be widely used in various acoustic sensors due to its low energy consumption. In addition, we propose a new parallel CRNN model with an attention mechanism and obtain superior results in speech digital recognition tasks.

Data Availability

The dataset is available upon request.

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Retraction

Retracted: Friction Performance Analysis of Reactor Coolant Pump Shaft Seal Based on Sensor and Computer Simulation

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] Q. Gou, S. Xiao, and X. Chen, "Friction Performance Analysis of Reactor Coolant Pump Shaft Seal Based on Sensor and Computer Simulation," *Journal of Sensors*, vol. 2022, Article ID 7838491, 11 pages, 2022.

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Research Article

Friction Performance Analysis of Reactor Coolant Pump Shaft Seal Based on Sensor and Computer Simulation

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In recent years, the state has put forward a grand plan to develop nuclear power in order to control environmental pollution and carbon emissions. In nuclear power plants, mechanical seals for reactor coolant pump play an important role in nuclear power safety production. However, China cannot independently produce such mechanical seals, and they are blocked by foreign related technologies, which has seriously affected China's nuclear power development plan and the overall safety of China's nuclear power operation. Under this background, this paper studies the friction performance of the shaft seal of the reactor coolant pump, uses the sensor to obtain the data of friction factors such as low-pressure leakage, effectively monitors the low-pressure leakage through calculation and simulation modeling, truly reflects the operating state of the reactor coolant pump, and provides a new research direction and experimental basis for further analysis of the friction performance of the shaft seal of the reactor coolant pump. The results show that under the joint action of the pressure difference and the force generated by the deformation of the moving ring plate, the cone angle formed on the seal end face is 1300.9 μ convergence gap of rad. When the inlet water temperature is 65°C, the leakage rate is 1867.8 L/h. The deformation of the moving ring deformation ring plate can hinder the increase of the deformation cone angle of the moving ring. The greater the thickness of the moving ring deformation ring plate, the greater the seal leakage rate. The inlet temperature of the sealing medium and the friction performance of the material also have an impact on the sealing performance.

1. Introduction

Energy is the material basis of economic and social development. With the growth of population and economy and the improvement of electrical automation, the demand for energy will continue to grow. Taking fossil energy as the main energy has caused the deterioration of the global ecological environment, so it is urgent to promote the transformation of energy to clean and renewable direction, and the growth of nuclear power is a key component of degree to encourage the transformation of power structure in the coming days [1, 2]. Compared with fossil energy, nuclear energy is a clean, environmental friendly, low-carbon energy, and will not face the risk of resource depletion for the time being. Therefore, the development of nuclear power should meet the demand for clean energy. Nuclear power plays a key component of part in neat energy. The potential safety endanger of utilizing nuclear power lies in the leakage of nuclear substances. At present, most pressurized water reactor nuclear power plants in China use shaft seal coolant pumps. Shaft seal is an important component of the coolant pump, which ensures that the radioactive reactor coolant will not leak out through the coolant pump under normal working conditions. The shaft seal design structure is complex, and the processing is precise. At present, only a few coolant pump suppliers in the world have mastered this technology. The shaft seal of the reactor coolant pump prevents radioactive cooling water from entering the air [3]. The seal of the reactor coolant pump is easy to wear due to its extreme working conditions. The shaft seal technology of the reactor coolant pump is closely narrated to the safety and dependable manner of the reactor coolant pump. However, the average localization rate of nuclear power equipment in China is 45%, and some key parts are almost all

imported. The localization of nuclear power equipment is imperative.

Reactor coolant pump (RCP) is the "heart" of nuclear power plant, and its main function is to pump the coolant required by the reactor into the reactor system, so that the coolant can be recycled in the reactor system [4, 5]. According to the different sealing forms of the RCP, the RCP is divided into shaft seal pump and shielded pump. Shield pump is designed to integrate the sealing device and pump as a whole, which can ensure that the coolant in the pump will not leak, but its efficiency is relatively low, and it cannot continue to be used after the power failure of the nuclear power plant. Therefore, it is gradually replaced by the shaft seal pump in the development process of the sealing technology of the RCP, but some types of shield pumps are still used in nuclear power plants. Just now, shaft seal pumps are mostly utilized during the second and third generation nuclear power plants. Shaft seal is an intention to temperance the leakage of shaft seal pump, and its performance is closely narrated to the approach safety, patch up, and maintenance cycle of nuclear power plant [6, 7]. The shaft seal in the shaft seal pump belongs to mechanical seal according to the classification of seal, which is the key auxiliary component in the RCP. Once the nuclear power plant leaks, it will cause huge losses and even disasters. In 1979, the reactor of the Three Mile Island nuclear power plant in the United States leaked, causing huge economic losses. The Chernobyl accident in Ukraine in 1986 is known as the worst nuclear power disaster in history. In 2011, the power failure of Fukushima nuclear power plant in Japan caused the RCP to stop working due to the earthquake, resulting in the leakage of radioactive substances, causing a global crisis. The mechanical seal at the shaft end of the RCP is used to limit the leakage of the nuclear reactor coolant along the pump shaft and force it to flow to the chemical volume control system or the nuclear reactor coolant drain tank as much as possible. The failure of the seal of the RCP will not only bring huge economic losses but also pose a potential threat to the safety and health of the public. In recent years, with the development of nuclear power in the world, mainly the speedy growth of nuclear power in China, the seal of RCP has got grand attention. Many scholars have conducted more in-depth research on the seal of RCP, and a large number of relevant documents have been published. With the development of rubber and various auxiliary materials, shaft sealing materials are constantly improved to meet the harsh sealing conditions. Its friction and wear performance directly determines the serviceability and service life of the seal ring. In order to ensure the safety and reliability of the shaft seal under the actual working conditions, the experimental research on the friction and wear characteristics of the shaft seal material is of great significance.

In the RCP, the mechanical seal is a vulnerable equipment, which is also prone to failure. The failure caused by the mechanical seal accounts for more than half of the coolant pump accidents, so the mechanical seal, as the key equipment of the nuclear power plant, plays a key part in the trustworthy and dependable practice of the nuclear power plant. Therefore, we should master the key technology of the design of the mechanical seal for the RCP as soon as possible and get rid of the bondage of foreign mechanical seals on the development of nuclear power in China; it is an important point and a need to swiftly encourage the advancement of national nuclear power industry. Based on the above situation, these notes present a survey on the friction performance of RCP shaft seal based on sensors and computer simulation. Taking the new streamline groove mechanical seal for RCP as the research object, the lubrication model of streamline groove mechanical seal is established, the influence law of end face parameters on sealing performance is analyzed, and the end face parameters are optimized by single variable method and orthogonal experiment method, which provides effective support for improving the basic theory of RCP sealing technology. Experiments show that the seal face produces circumferential waviness and radial taper. With the increase of seal pressure, the wavy deformation and taper deformation of seal face increase. The thickness of lubricant film between seal faces increases with the increase of seal pressure, and the friction coefficient decreases with the increase of seal pressure.

In this study, sensor and computer simulation technology are used to study the friction performance of RCP shaft seal. This study will elaborate the research process of shaft seal friction of RCP from five aspects. The first part introduces the background and significance of the research on the sealing of RCPs at home and abroad. The second part summarizes the shaft seal technology and research status of RCP. The third part is based on the sensor and computer simulation technology to study the friction performance of the RCP shaft seal. Section 4 is the experimental analysis and result comparison. Section 5 analyzes and summarizes the full text and prospects the future research direction.

2. Related Work

Mechanical seal is an axial rotating sealing device that relies on the joint action of elastic elements and sealing medium pressure to maintain the fit of two sealing faces, so as to realize sealing. Mechanical seals can be divided into contact type and noncontact type according to whether the end faces of the two seal rings are in contact. Contact mechanical seal has the benefits of easy structure and low leakage rate, but because of its large end wear and calorific value, it is not suitable for the application of high temperature, high pressure, and other occasions. Noncontact sealing refers to the phenomenon that the noncontact sealing device does not contact with the shaft, does not produce friction, and has oil grooves, oil slingers, labyrinth seals, etc. The existing noncontact sealing technologies include gas film seal and liquid film seal. The medium delivered by the RCP is the coolant with high temperature, high pressure, and high radiation. The ordinary contact mechanical seal cannot meet the requirements of its service conditions, so the mechanical seal for the main pump often adopts the noncontact mechanical seal with deep groove on the sealing end confront or taper on the end confront [8, 9]. In normal operation, because the two seal faces are not in contact, the wear of the seal face

is small, and it can operate stably in high-pressure occasions for a long time.

Because of the speedy advancement of science and tech and the high parameter requirements of sealing conditions, the design of mechanical seals presents a more severe challenge. At present, mechanical seals are developing rapidly in the direction of high parameters such as high pressure and high temperature. Using sensors to obtain shaft seal friction data in real time and then using computer simulation technology to simulate and analyze the data is the current hot research direction of this research, which is more conducive to real-time, accurate, and specific analysis. Generally, the deformation of the seal end confront and the thickness of the lubricating liquid movie are overall in similar bid of importance [10]. Under high parameters, the deformation of the mechanical seal end confront has a great impact on the thickness of the lubricating liquid film, so it will also affect the sealing performance. Mechanical seal face deformation is mainly caused by force deformation (mechanical deformation) and thermal deformation (temperature deformation). The mechanical deformation of the seal ring is mainly caused by the joint action of medium pressure, liquid film pressure, spring force, contact load, etc. When the mechanical seal works normally, the temperature distribution of the seal ring will change due to the effect of factors such as the temperature of the seal medium and the friction heat caused by the relative movement of the two seal faces, and the seal ring will be deformed to varying degrees due to uneven heating. In particular, the end face will produce taper and waviness due to deformation.

As for the study of mechanical deformation of seal ring, Gemma ring theory, pitzino ring theory, gram body torque theory, finite element method, finite difference method, and finite volume method are used as usual. Zhang et al. [11] simplified the seal ring into a cylinder according to Gemma ring theory and obtained the deformation and rotation angle of the seal ring. In addition, the author used the finite element method to calculate the thermal deformation of the mechanical seal and found that the temperature difference of the seal face will deform the flat seal face. Although the finite element software has powerful functions, it also has certain limitations. For example, for mechanical seals with shallow grooves on the end face, the groove depth is micron level and the groove width is millimeter level, which brings some difficulties to modeling and meshing. Literature [12] studied the influence of force deformation and thermal deformation on the performance of hydrostatic mechanical seals by establishing a two-dimensional thermoelastic hydrodynamic lubrication model (TEHD). Literature [13] simplifies the seal ring into an axisymmetric model and analyzes the force deformation of the seal ring by using the ring theory and two-dimensional finite element model, respectively. The results show that this method has a good effect on calculating the deformation of complex seal rings. This method simplifies the results calculated from the modeling analysis and simplifies the complex engineering problems that feel there is no place to start. But the accuracy fluctuates greatly. Based on the level and boundary conditions of modeling, whether the simulation of load cases is true, etc. Gong et al. [14] used the general finite element method to discuss the influence of seal interface wear on tropical migration. The wear simulation program is used to calculate the wear of the seal ring, and the thermoelastic effect is also included in the simulation model. The results show how wear affects the migration of hot rolled strip, and the wear of sealing surface leads to more complex tropical migration state, including the division and combination of tropics. The proposed simulation method and program are suitable for trend analysis of seal design. Wittmaack et al. [15] used the finite element method to study the mechanical deformation of the mechanical seal ring of the high parameter compressor. In this method, the continuous solution domain is discretized into a combination of a group of elements, and the approximate function assumed in each element is used to represent the unknown field function to be solved in the solution domain. The approximate function is usually represented by the numerical interpolation function of the unknown field function and its derivatives at each node of the element. The results show that the working pressure difference causes the force deformation of the seal ring. Under high pressure, the force deformation of the seal ring has a great impact on the sealing performance, which cannot be ignored. Literature [16] uses the boundary element method to calculate the deformation of the mechanical seal. The deformation of the seal ring is numerically calculated and compared with the experimental value. It is found that the boundary element method can better solve the end face deformation. Literature [17] put forward a TEHD numerical analysis model of mechanical seal considering the influence factors such as heat, inertia effect, and turbulence and analyzed the thermal deformation of the seal ring by calculating the heat conduction between the fluid film and the seal end face. The results show that the deformation of the end face has an important influence on the thickness of the lubricant film on the seal end face. TEHD method is to consider not only the comprehensive influence of temperature change on fluid pressure generation and viscosity change but also the influence of pressure and temperature gradient in bearing bush on thrust bearing performance in numerical analysis block deformation, so the simulation results obtained by TEHD method are more accurate. Ding et al. [18] established a fluid solid coupling theoretical analysis model of deep groove end face density and obtained the pressure distribution, liquid film thickness, and leakage rate of the liquid film by using the numerical calculation method. It was found that the wavy deformation of the seal end face would occur due to the effect of the deep groove, resulting in the hydrodynamic pressure effect due to the extrusion of the liquid film at the convergence gap in the direction of speed rotation.

At present, domestic and foreign scholars' research on the sealing ring mainly focuses on the design and optimization of the sealing structure, as well as the unilateral performance of the sealing ring material, such as the aging performance of composite materials. Most of them mainly focus on the aging mechanism of materials, mechanical properties of materials, etc., but there is less research on the change law of friction and wear of composite materials

after aging. Through the analysis of the above research status, it can be found that at present, China's research on mechanical seals for RCP mostly stays in theoretical research, and there is little research on experimental analysis and application introduction, which indirectly explains the development stage of RCP in China, but it is through these stages that China can consolidate the theoretical foundation and further promote the development of RCP sealing technology and pave the way for the complete autonomy of the RCP seal in China. This paper presents an analysis method of shaft seal performance based on sensor and computer simulation technology. Over theoretical calculation, it is found that its performance parameters are improved compared with the existing mechanical seal with groove on the end face, mainly in terms of opening force, stiffness, and bearing capacity. At the same time, its surface hydrodynamic effect is also better, so it is applied to the RCP seal.

3. Simulation Analysis of Shaft Seal Friction Using Sensor Data

3.1. Sealing Performance Parameters. When the streamline groove mechanical seal works, due to the setting of the groove on the sealing end face, there is a convergence gap, and the relative rotation of the sealing end face forms a fluid film with a certain stiffness, so as to achieve the sealing effect [19]. To study the sealing performance of mechanical seals is essentially to study the application of hydrodynamic lubrication theory in mechanical seals. Hydrodynamic lubrication refers to the lubrication state in which the fluid between the two end faces of the friction pair depends on the uneven shape of the end faces of the friction pair, and there is a convergence gap. When the two end faces move with each other, the fluid between the end faces forms a fluid film due to the hydrodynamic effect, which separates the moving end faces from each other. In 1883, tower tested the bearings of train axles and observed the phenomenon of hydrodynamic pressure for the first time. In 1886, Reynolds put forward the basic equation of lubrication theory based on the knowledge of fluid mechanics, successfully revealed the mechanism of fluid film, and laid the foundation for modern fluid lubrication theory. From the perspective of mathematics, the main content of hydrodynamic lubrication theory is the solution of Reynolds equation.

3.2. Continuity Equation. In fluid mechanics, the continuity equation is the specific expression of the law of conservation of mass [20]. The premise of its application is that the velocity and density of fluid medium are continuous. If the flow between seal faces is stable, the mass of fluid flowing out of a certain area must be equal to the mass of fluid flowing in. If the flow between the seal faces is in an unstable state, the difference between the mass of the fluid flowing into a certain area and the mass of the fluid flowing out must be the value that causes the mass change in that area. In mathematical form, it is the continuity equation. As shown in Figure 1, assuming that the area is a cube, the continuity equation is solved according to the average flow model.

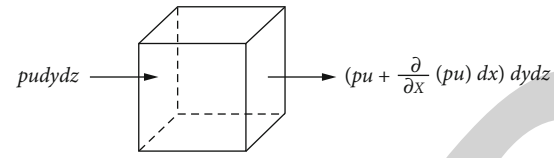

Figure 1: Micro flow diagram.

Taking the x direction as an example, the mass flowing in from the left side per unit time is $pudydz$, and the mass flowing out from the right side per unit time is as shown in the following formula:

$$\left[pu + \frac{\partial}{\partial x}(pu)dx\right]dydz. \tag{1}$$

The mass difference of flow in and out in X direction in unit time is

$$\left[pu + \frac{\partial}{\partial x}(pu)dx\right]dydz - pudydz = \frac{\partial}{\partial x}(pu)dxdydz. \tag{2}$$

Similarly, the quality difference of outflow and inflow in Y direction and Z direction is

$$\left[pv + \frac{\partial}{\partial y}(pv)dy\right]dxdz - pvdxdz = \frac{\partial}{\partial y}(pv)dxdydz, \tag{3}$$

$$\left[pw + \frac{\partial}{\partial z}(pw)dz\right]dxdy - pwdxdy = \frac{\partial}{\partial z}(pw)dxdydz. \tag{4}$$

The mass increased by density per unit time is $(\partial p/\partial t)$ $dxdydz$. That is

$$\frac{\partial p}{\partial t}dxdydz + \left[\frac{\partial(pu)}{\partial x} + \frac{\partial(pv)}{\partial y} + \frac{\partial(pw)}{\partial z}\right]dxdydz = 0. \tag{5}$$

The general form is

$$\frac{\partial p}{\partial t} + \frac{\partial(pu)}{\partial x} + \frac{\partial(pv)}{\partial y} + \frac{\partial(pw)}{\partial z} = 0, \tag{6}$$

where pu, pv, and pw refer to the flow per unit length in the x, y, and z directions, respectively; $\partial/\partial x(pu)dx$, $\partial/\partial y(pv)dy$, and $\partial/\partial z(pw)dz$ refer to the flow change rate in the x, y, and z directions, respectively.

3.3. Expression of Mechanical Seal Performance Parameters

3.3.1. Opening Force. The opening force refers to the bearing capacity of the fluid film [21]. After the pressure distribution of the sealing face is obtained, the opening force is obtained by integrating it on the whole sealing face. The opening force is used to describe the force that keeps the seal face open. When the opening force is balanced with the closing force, the seal operates stably. The calculation formula of opening force is

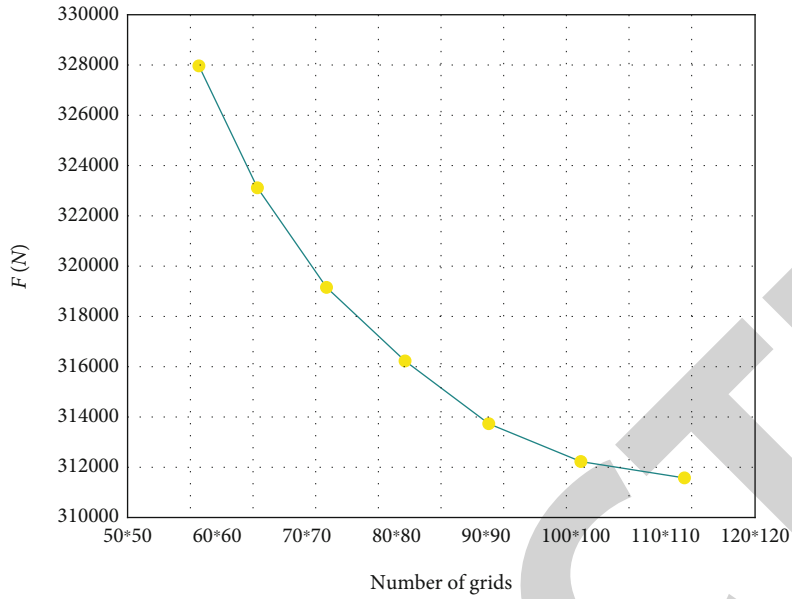

Figure 2: The grid independence test and verify.

$$F0 = \int_0^{2\pi} \int_{r0}^{ri} prdrd\theta, \tag{7}$$

where F_0 is the opening force; θ is the circumferential boundary angle; r_0 and r_i are the radial boundary.

3.3.2. Leakage Volume. Leakage is the most important performance parameter to evaluate the mechanical performance [22, 23]. It refers to the amount of sealing medium leaking between sealing ends in a unit time. At present, the leakage formula under mixed lubrication provided by Mayer in Germany is generally used in the study of leakage:

$$Q = -\int_0^{2\pi} \left(\frac{h^3}{12\mu} \frac{\partial p}{\partial r} \right) rid\theta, \tag{8}$$

where r_i is the dimensionless inner diameter; p is the dimensionless internal pressure.

The opening leakage ratio refers to the ratio of opening force and leakage rate, and its calculation formula is

$$Ef = \frac{F0}{Q}. \tag{9}$$

3.4. Numerical Solution of Reynolds Equation

3.4.1. Finite Difference Method (FDM). Reynolds equation contains partial differential items, so it is very troublesome to find its analytical solution. Although many experts and scholars have made in-depth research on it, the effect is very little. At present, the treatment method of Reynolds equation is mainly numerical calculation method. FDM, FEM (finite element method), FVM (finite volume method), and emerging geometric analysis methods are mostly used. Each method has its applicable occasions. Among them, FDM is the earliest kind of method. Its basic idea is to draw a differential grid in the solution area. The variables and their differential terms in the equation are expressed by nodes or difference quotients of nodes and are simplified into differential algebraic equations through transformation. FEM is used to deal with more complex solving regions, and FVM is suitable for solving complex regions and solving regions with flexible meshing. Surface modeling technology is developing rapidly, and the limitations of the above methods hinder its development and application. The emergence of geometric analysis overcomes the limitations of traditional finite element analysis in mesh generation and can not only improve the numerical accuracy of the analysis model but also greatly improve the analysis efficiency. FDM is selected as the regional comparison rule studied in this paper. Although other methods will improve the accuracy of numerical calculation, it will increase a lot of calculation. Therefore, FDM is used for comprehensive consideration.

3.4.2. Grid Independence Verification. The number of meshes will affect the accuracy of numerical analysis, so it is necessary to select the appropriate number of meshes to discretize the solution area. Too many grids will lead to too long calculation time, and the fluctuation range of calculation results is not large, but if the number is too small, it will seriously affect the accuracy of numerical simulation. Therefore, it is necessary to select an appropriate number of grids to reduce the deviation of calculation results caused by the number of grids.

As shown in Figure 2, the opening force first decreases rapidly, then decreases slowly, and finally tends to be stable with the increase of the number of grids. When the number of grids is greater than 100×100, the opening force changes little, and the error is less than 1%, so the selected number is 100×100, but in order to distinguish the difference between

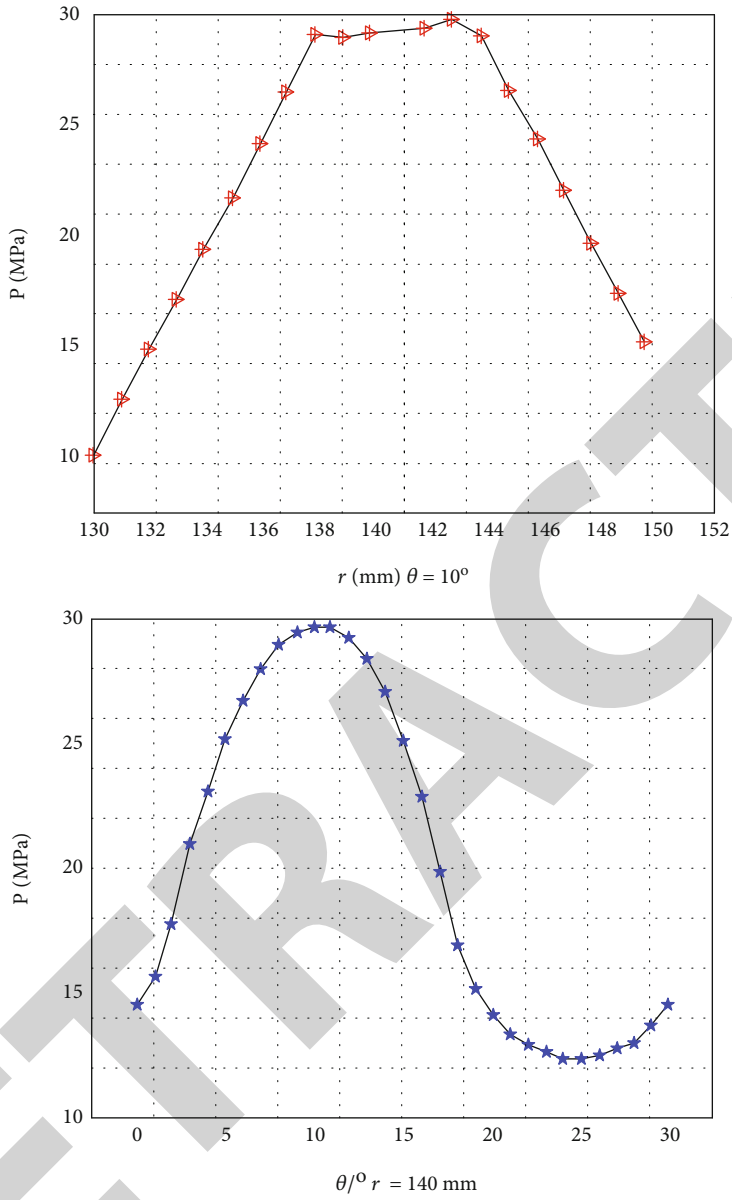

Figure 3: Radial and circumferential pressure distribution of fluid film.

the inner diameter direction and the circumferential direction of the calculation area, the number of grids in the circumferential direction is 120, and the final number of grids is 100 × 120.

3.4.3. Fluid Film Pressure Distribution. Figure 3 shows the radial and circumferential distribution curves of pressure. When studying the radial distribution law, take the circumferential direction $\theta = 10^{\circ}$, it has the ability to be seen from the figure that along the direction of radius reduction, the pressure first increases, then passes through a stable stage, and finally gradually decreases. The section with radius $r = 130 \sim 138$ mm is a sealed dam, the section with radius $r = 138 \sim 144$ mm is a groove area, and the section with radius $r = 144 \sim 150$ mm is a sealed weir. Due to the dynamic pressure effect, the pressure value in the groove area is larger than that in the dam area and weir area. Therefore, taking the groove area as the center, the pressure value towards the dam area and weir area gradually decreases, and finally, the pressure value reaches the boundary value of the seal ring pressure. When studying the circumferential distribution law, take $r = 140$ mm. It has the ability to be seen from the figure that with the increase of the circumferential degree, the pressure value first increases and then decreases and finally gradually increases to and $\theta =$ Value at 0°. When $r = 140$ mm, $\theta =$ the range of $0 \sim 15^{\circ}$ is the groove area, and the direction of angle increase is the direction of fluid inflow, so the pressure value gradually increases, $\theta =$ the section at $15 \sim 25^{\circ}$ is weir area, and the pressure value gradually decreases, $\theta =$ the interval between 25° and 30° is the groove area of another calculation area, so the pressure value gradually increases. At the same time, due to the boundary conditions set in the circumferential direction, the pressure value will reach $\theta =$ value at 0°.

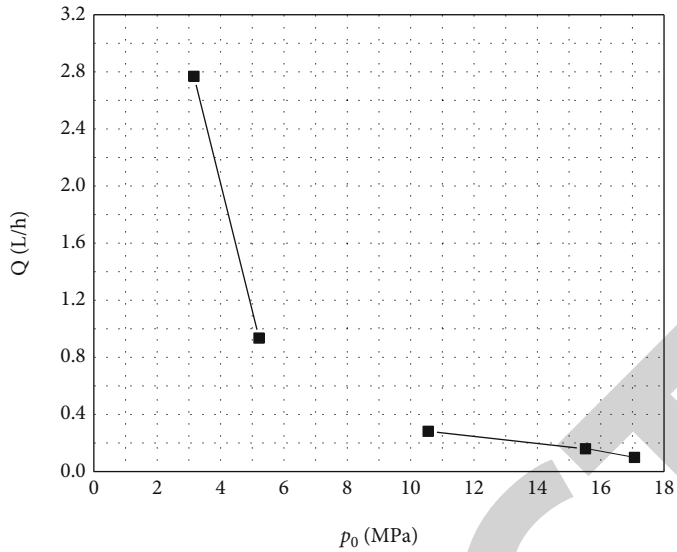

Figure 4: Variation law of leakage with force.

4. Simulation Experiment Analysis of Shaft Seal Friction of RCP Based on Sensor

At present, the theoretical and practical research on hydrostatic mechanical seals for RCP has become mature, and the theoretical research and related experimental research on shaft seal friction based on sensors and computer simulation need to be further improved. Using sensor and computer simulation technology, the reusability and scalability of the simulation model are mainly considered. Problems in the field of industrial applications are generally complex, and many types of decision variables coexist, such as continuous and discrete decision variables. There are quantitative and qualitative problems in discrete decision variables, and the size of different types of problems in the same field is also different. Therefore, we should pay attention to the research on the ability of simulation optimization algorithm to solve the problem range. Especially in China, the relevant research on the RCP seal for sensors is in its infancy, and the relevant experimental research is less [24, 25]. There is a great difference between the theoretical research and experimental research of mechanical seals, because the theoretical analysis is often obtained through a large number of simplifications, for example, ignoring the possible errors in the actual installation, the vibration of mechanical devices, the inertia effect, and other factors. Therefore, experimental research is a research method that can better reflect the real situation of mechanical seal operation.

This chapter uses sensor data and computer simulation data to conduct experimental research on the friction performance of the shaft seal of the RCP, analyzes the change law of the sealing performance with the operating parameters, and analyzes the change of the seal face morphology before and after operation, so as to lay a test foundation for optimizing the mechanical seal of this structure in the future.

4.1. Experimental Steps

Step 1. Install the mechanical seal correctly, check the installed equipment accordingly, and check the static pressure of the seal cavity.

Step 2. Start the motor, adjust the speed, and observe whether the motor operates normally. Then, it is necessary to record whether the operation is normal under no-load state.

Step 3. Conduct static pressure test, start the three-stage plunger pump, and add water to the sealing cavity. When the cavity is filled with water, the pressure of the liquid in the sealing cavity is changed by adjusting the bypass valve. Under different pressures, the pressure sensor records the leakage rate of the end face. After changing the pressure every time, wait about 5 minutes before recording the data. Use a measuring cylinder to measure the leakage rate, each time for 6 minutes, a total of 3 times, and finally take the average value. After the static pressure test, restore the pressure to the initial value and prepare for the operation test.

Step 4. Start the motor, slowly increase the speed to 1485 rpm after running in at low speed, and then operate the mechanical seal for a period of time. After the mechanical seal operates stably, carry out the next test. Adjust the pressure passing through the seal chamber and record the friction torque and leakage rate of the mechanical seal. After changing the pressure every time, wait about 0.5 hours before recording the data. It takes a long time for the mechanical seal to operate stably due to dynamic pressure. Use a measuring cylinder for measurement, each measurement time is 6 minutes, a total of 3 measurements, and finally take the average value.

Step 5. Conduct the life test, stabilize the pressure at 15.5 MPa, rotate at 1485 rpm, and conduct the 100 h long-

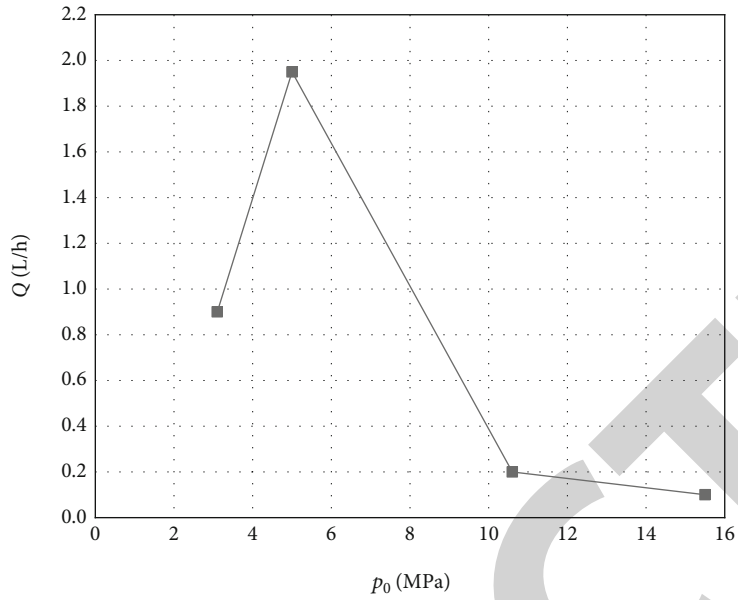

Figure 5: Variation law of seal leakage with pressure.

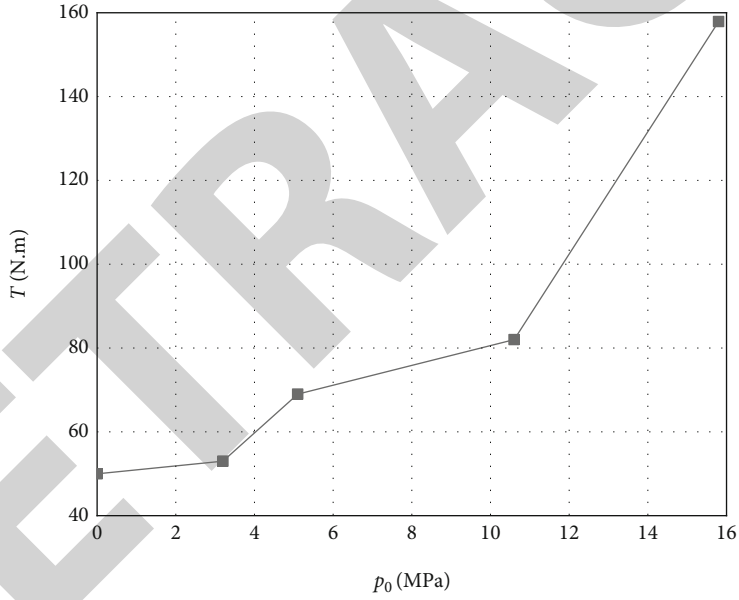

Figure 6: Variation law of friction torque with pressure.

term operation test. During the test, the data shall be recorded every 2 h.

Step 6. After the 100 h operation test, study the influence of the change of operating parameters on the sealing performance by adjusting the pressure and speed, and record the relevant test data. The measurement method is the same as that in Step 4. In addition, it is necessary to compare and analyze the recorded data with the data before the operation test.

Step 7. Disassemble the sealing device, check the friction and wear condition of the seal ring end face, make corresponding records, and analyze and explain the phenomena in the previous test through the changes of the seal ring end face morphology.

4.2. Test Results and Discussion

4.2.1. Static Pressure Test. After the assembly of the test device, the static pressure test shall be carried out on the mechanical seal. Figure 4 shows the change curve of the leakage rate of the mechanical seal with the increase of the sealing pressure under the static state. It can be seen that the leakage rate decreases with the increase of pressure. The reason is that with the increase of the pressure of the sealing medium, the sealing face fits tighter, so the sealing leakage rate continues to decrease.

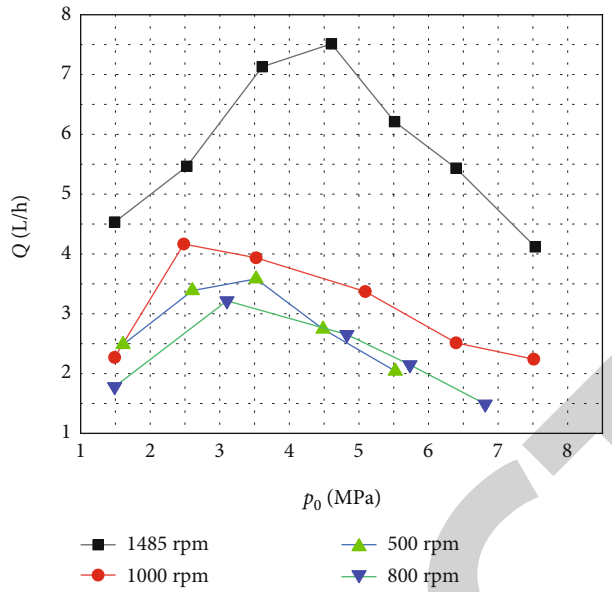

Figure 7: The variation of seal leakage rate with pressure at different rotating speeds.

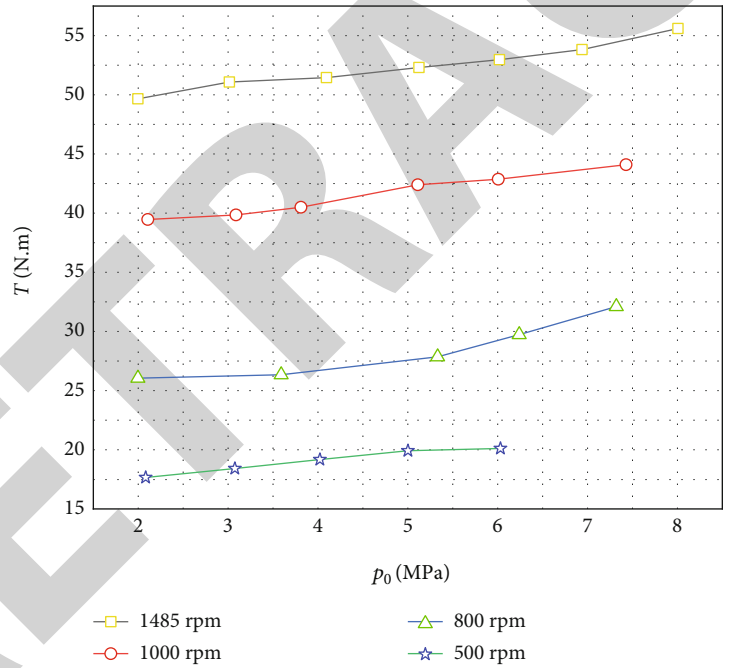

Figure 8: Variation of torque with pressure at different speeds.

4.2.2. Operation Test before Long-Term Running In. Figures 5 and 6 show the leakage rate and friction torque curves of mechanical seals under different sealing pressures. It can be seen from Figure 5 that the leakage rate between seal faces first increases and then decreases with the increase of sealing pressure. Under high pressure, the leakage rate between seal faces is almost zero. This may be because with the increase of pressure, the seal face deforms and has a weak hydrodynamic effect, which increases the leakage; when the pressure exceeds a certain value, the negative taper deformation of the end face may be large, resulting in the contact between the two end faces, thus reducing the leakage rate. The results shown in Figure 6 show that the friction torque of the seal face increases with the increase of pressure. This may also be caused by the tighter contact between the two seal faces when the pressure rises.

4.2.3. Operation Test after Long-Term Running In. Figure 7 shows the change of leakage rate with pressure at different speeds after 100 hours of end face running in. It can be seen that the leakage rate first increases and then decreases with the increase of pressure at different speeds. It can be seen

from Figures 5 and 7 that the leakage rate between seal faces is much higher after the mechanical seal has been operated for 100 h than that before operation, and the change law of the leakage rate with the increase of pressure has also changed. This may be because the outer edges of the two seal faces are seriously worn after 100 h operation of the mechanical seal under high pressure, resulting in the formation of a taper with hydrostatic effect at the outer diameter of the two seal faces. Therefore, when the pressure is small, the deformation of the end faces is small, and the liquid film between the seal faces is convergent, so the leakage rate increases; with the further increase of pressure, the deformation of the end face increases, and the liquid film on the sealing end face changes from convergence to divergence. At this time, increase the sealing pressure, and the leakage rate decreases.

When the pressure is fixed, Figure 7 also shows the change law of leakage rate with speed. Thus, when the pressure is less than 5 MPa, the leakage rate of the end surface decreases first and then increases significantly with the increase of speed. This is mainly because when the speed and pressure are low, there is less deformation between seal faces, and the speed has less influence on the liquid film on the end. When the rotating speed rises to 1000 rpm, the rotating speed has a great impact on the liquid film, so the leakage rate increases significantly. When the pressure and speed are large, the leakage rate between the end faces increases with the increase of speed. This is mainly because when the pressure increases, the hydrostatic pressure effect of the liquid between the seal faces increases, and with the increase of speed, it is conducive to improve the hydrostatic pressure and dynamic pressure effect of the lubricating liquid film, so the leakage rate increases with the increase of speed.

Figure 8 shows the variation curve of torque with pressure at different speeds. It can be seen that at different speeds, with the increase of pressure, the friction torque between the end faces gradually increases, which is not obvious. However, under the fixed seal pressure, the friction torque increases significantly with the increase of rotating speed.

5. Conclusions

In this paper, the friction of shaft seal of RCP is studied. The computer simulation technology is used to simulate and analyze the relevant data of friction obtained by the sensor. Considering the inlaid structure of the seal ring, the fluid opaque coupling version of the mechanical seal is established, the solution blueprint of the mathematical version is given, the influence law of the functioning parameters on the performance of the mechanical seal is studied, the influence of the geometric parameters of the seal ring and the structural parameters of the linear groove on the sealing performance are analyzed, and the optimized seal ring structure is obtained. The existing sealing products are tested and studied, the influence of operating parameters on sealing performance is studied, the causes of end face wear are analyzed, and the corresponding improvement measures are put forward. Through the above research, the essential conclusions are as follows.

Below the influence of the straight-line deep groove, the seal face produces circumferential waviness and radial taper. With the enhancement of seal pressure, the wavy deformation and taper deformation of seal face increase. The thickness of lubricant film between seal faces increases with the enhanced seal pressure, and the friction coefficient decreases with the increase of seal pressure. Because the influence of heat is not considered in the numerical calculation model, with the increase of rotating speed, the amplitude deformation between seal faces decreases, but the minimum film thickness increases, and the leakage rate does not alter remarkably with the increase of rotating speed.

In this paper, the research on the sealing face is based on the fact that the sealing rings are parallel to each other, but the actual work will inevitably produce heat, which will cause the deformation of the sealing ring and lead to the nonparallel sealing gap. At the same time, this paper does not consider the influence of temperature and surface roughness of seal ring on the performance parameters of mechanical seal, which should be improved in the future research.

Data Availability

The labeled data set used to support the findings of this study is available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Acknowledgments

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Retraction

Retracted: Construction and Quality Control of Subway Wet Loess in Concealed Tunnel Based on Particle Swarm Optimization Algorithm

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] W. Wang, X. Zhang, and X. Liu, "Construction and Quality Control of Subway Wet Loess in Concealed Tunnel Based on Particle Swarm Optimization Algorithm," *Journal of Sensors*, vol. 2022, Article ID 3655202, 13 pages, 2022.

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Research Article

Construction and Quality Control of Subway Wet Loess in Concealed Tunnel Based on Particle Swarm Optimization Algorithm

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To reduce urban pressure, urban rail transit has become an effective way to reduce traffic congestion, mitigate traffic accidents, reduce environmental pollution, and improve commuting efficiency. Subway as the main means of urban public transport travel, in recent years by people's favor, although the construction industry of rail transit is developing rapidly and the industry scale is expanding, but because the construction of rail transit construction projects is very difficult, especially in the wet loess within the concealed excavation tunnel, but also frequent accidents, and the quality of the project is not easy to guarantee, so the underground railroad wet loess within the concealed excavation tunnel construction technology is poor. Therefore, it is especially important to study the construction technology and project quality management of underground railway concealed tunnel in wet loess. In this paper, based on the in-depth study of the basic principle of quantum particle swarm optimization calculation and the realization of key engineering technologies, the particle swarm optimization algorithm is programed using MATLAB software, and the coding scheme, operation specification, and operation parameters are designed. Then, combined with the particle swarm optimization algorithm and assisted MATLAB software, the main analysis of the construction and quality control of wet loess in concealed tunnels of subway projects was carried out, mainly by systematizing the relationship between the three major elements of subway project schedule, cost, and management and the construction and quality control of wet loess in concealed tunnels of a subway, and concluded that the construction and quality control of wet loess in concealed tunnels of the subway needed schedule. It is concluded that the construction and quality control of subway wet loess tunnel requires stable schedule, adequate cost budget, and management personnel.

1. Introduction

In real life, there are different solutions for many things, as well as in scientific research, and it is especially important to find the most optimal algorithm. Finding the optimal algorithm to achieve optimal results in engineering or management activities is sometimes a very important research direction, for example, how to determine the selection parameters in some engineering and technology sciences and in some economic and technical management disciplines. The list of how to maximize the use of all resources of a limited scope of human beings in limited resource allocation activities, so that the process of program allocation in a program fully satisfies all the basic needs of life of all people and at the same time obtains good and considerable economies of scale was created; in all other relevant areas involving the field of human activity, the list is endless. In fact, these group mathematical problems are often first set up as a set of mathematical models through a series of numerical transformations containing certain mathematical procedures, which are eventually abstracted into some of the basic mathematical logical constraints or conditions of the system using the transformed models, finding any set of them with a specific set of parameter-valued variable

conditions or constraint functions, so that some other of them can achieve some kind of desired in the course of the problem system. The maximum performance or a minimum performance is in fact a group problem optimization. The particle swarm optimization swarm algorithm is also a relatively new conceptual meaning of the group intelligence nature of the optimization swarm algorithm. Its technology and its main algorithm performance characteristics are mainly the principle structure of the algorithm which is relatively simple and has less parameter constraints, convergence algorithm speed, and the need to study the relevant field of knowledge threshold less. This series of algorithms has been successfully and widely used in many related fields such as generalized function optimization, neural network training, and combinatorial algorithm optimization research and has achieved good results. Due to its simple principle and fast algorithm, particle swarm optimization algorithms are widely used in various research fields, such as mathematics, chemistry, computer technology, and engineering. Although particle swarm optimization has developed greatly in the past decade, both theoretical analysis and practical application are still not very mature, and there are still many problems worthy of research, but the particle swarm optimization algorithm has also solved many technical problems in related fields, and the quality control and research in the field of subway tunneling has been slightly achieved [1].

Due to the increasingly developed market economy in China, the accelerated urbanization process has led to the rapid growth of urban population, road congestion, and people's travel problems are also big problems faced in today's cities. Rail transit is popular among the people because of its low pollution level, small footprint, low construction investment, and high transportation capacity. It has begun to occupy an increasingly important position in the field of urban transportation. However, the difficulty of rail transit construction and the high requirements for technical standards have made the management of rail transit construction quality increasingly very difficult. And rail transit development has become a major strategic project in China's urban modernization process, playing a crucial role in the development of China's local economy and society. Under the constraints of resources and environment, China's urbanization needs to take the route of intensive and compact development, which is both the need of the real environment and the inevitable requirement to achieve sustainable development. The development of metro is to achieve economies of scale in urban infrastructure and effectively reduce the income gap between regions. The subway is an important part of urban public transportation and has the attributes of a public good. The development of metro has a certain consumer noncompetition and a strong public good. Large cities, especially megacities, should give full play to the quality advantages, convenience, and punctuality of metro transportation, maximize the cost performance advantages of urban rail transportation, effectively control the speed of urban motorization, and play a key role in the economic development of urban transportation systems. With the increased government investment in subway projects, the development of subway construction projects in China can be described as extremely rapid, but the difficulty of subway construction is great, especially in the process of wet loess in concealed tunneling; safety accidents occur frequently and the quality of the project is difficult to be reasonably assured, so the construction and quality control of wet loess concealed tunneling in subways is particularly important [2].

In this paper, it is on the basis of the basic principles and implementation techniques of quantum particle swarm optimization algorithm, the particle swarm optimization algorithm is programed using MATLAB software, and the coding scheme, operation specification, and operation parameters are designed. Then, combined with the particle swarm optimization algorithm and assisted MATLAB software, the main analysis of the construction and quality control of wet loess in concealed tunnels of subway projects was carried out, mainly through the systematic analysis of the relationship between the three major elements of subway project schedule, cost, and management and the construction and quality control of wet loess concealed tunnels of subway, and concluded that the construction and quality control of wet loess in concealed tunnels of the subway needed schedule The conclusion of stable, cost-optimized, and management in place is developed and discussed.

2. Research Background

This section introduces the development of particle swarm optimization algorithm and the development and literature review of quality control of metro project construction management. It lays the foundation for the following research.

2.1. Particle Swarm Optimization Algorithm. After more than ten years of research, the particle swarm optimization algorithm has made some great progress in both engineering applications and computational performance optimization research [3]. The functional changes are mainly reflected in dealing with constraints and optimization problems; for example, Liu et al. used particle swarm optimization to deal with optimization computation problems based on constraints of equations with parameter equations; for example, Cao et al. used particle swarm optimization to deal with geometric constraint problems; for example, Wang et al. used particle swarm optimization to solve discrete optimization solutions of geometric constraint problems; Lu and Sun et al. tried to use particle, and Zhao et al. have also experimented with particle swarm optimization to solve the stochastic loader problem of spacecraft; and Lu and Sun et al. have tried to use particle swarm optimization to study and solve the optimal attitude control problem of manned spacecraft during solar panel extension. The optimal attitude control problem proposed in the dynamic control problem; and Li and Zhang, respectively, have tried to use particle swarm optimization to optimize the dynamic quantization factor in the fuzzy controller parameters online to ensure that the final obtainable equilibrium fuzzy controller parameters in the dynamic optimal control value problem; Guan et al. have separately proposed or studied and completed a nonlinear particle swarm dynamic optimization based on model predictive control and independently. The results of the

experiments have shown that the optimal control method is mainly applied to nonlinear, particle swarm rolling optimal control algorithm can also be applied to the control system of urban intelligent loop traffic intelligent coordination at the same time; the effect is also a relatively good. For example, the particle swarm optimization algorithm can also be widely used in the optimization of complex or multiobjective process systems. The algorithm was applied to the dynamic multiobjective optimization of a flow-plus-batch bioreactor with satisfactory results [4]. A total of 21 individuals, including Xiaoming Zhang, used the particle swarm optimization algorithm applied to the multiobjective optimization of hydrological model parameters with good results and significantly better deadlock resolution than other available methods. It is also clear from the above example analysis that from the latest research in computer application theory, the particle swarm optimization algorithm is being used by scientists to help solve those increasingly complex physical problems, and at the same time, the optimization improvement methods of the particle swarm optimization algorithm structure will become more and more complex and refined, and the optimization algorithm performance has indeed been improved to a great extent, but the main improvement in the performance of the optimization algorithm. The task is not yet finalized. How to achieve more efficient and accurate and more intuitive and concise intuition to improve the algorithm itself computing performance should still be a current hot spot of algorithm research [5].

2.2. Engineering Quality Control. Foreign experts and scholars have an early start on the research of engineering quality management. In 1966, American scholar Armand Feigenbaum first proposed the concept of "quality management" [6]. Quality management is based on cost control, meeting the standards and requirements of users, carrying out a series of market and industry, design, manufacturing, and operation services through a series of studies, and finally forming an effective and unified total quality management system. From the perspective of quality management methods, the development of quality management has gone through four stages, a development process of traditional management stage, quality inspection stage, statistical quality management stage, and total quality management stage. In the traditional quality management and quality inspection stage, the American scholar Taylor created the scientific management theory [7]. The scientific management theory will refine the division of labor, set standards by professionals, check manufacturing and dedicated personnel by professionals, and introduce quality inspection instead of the original operator quality management. The subdivision of functional management structure, screening products, separating qualified and unqualified products, strictly controlling the production process, and preventing quality flow have positive implications for improving product quality. However, quality inspection also has its limitations, as it can only be done at a later stage. With the development of society, new quality management methods have emerged. American scholars Hugh Hart through the theory and time research established the project management early quality problem prevention and quality management late quality inspection of defect prevention theory. In research methods and materials from the quality control process, foreign scholars have established some relatively sound theoretical systems. The whole process quality control is equally divided into five aspects: planning, experiment, construction, inspection, and overall error correction, focusing on the management function of people [8]. John Christian puts forward the concept of quality control and quality control measures, according to the requirements of users and project quality requirements, the implementation of project quality control in each stage, the implementation of project tasks in stages, the control of construction, and quality, construction, technology, and quality system improvement. Sharif and other scholars pointed out that it is easy to find quality problems in the construction process; these quality problems should be foreseen in advance, not delayed to the final acceptance of quality, engineering quality control should focus on the following aspects: people, machinery, materials, methods, environment, from small to large, from micro- to macroquality control. Think that the construction of information sharing features is of great help to the project construction, through the prophase project quality control, construction process control, and engineering projects late control to guarantee the quality of the project, so as to guarantee the quality of the project, make full use of the construction of information technology, and improve the quality of project construction.

In large infrastructure construction, especially in the subway construction under the background of rapid development, project quality management in our country concrete scientific measures must be adopted to constantly improve the quality of the project management level, must find a more scientific evaluation methods, and judge the practicality, and applicability of the quality management system will also be improve quality management level important segment. Duohongxia and Huang Zhibin believe that in order to strengthen and improve construction quality management, and the level of construction quality management system should adopt the method of hierarchy analysis, evaluation, and fuzzy comprehensive evaluation. After Song Ziyuan proposed the establishment of the evaluation index system, the analytic hierarchy process was used to calculate the weight value of each link of the project system, the comprehensive evaluation model of project quality was established, and the comprehensive evaluation method of the operation effect of the project quality management system based on the dimensional analysis method was put forward. He says more and more stringent quality control standards and mechanical and electrical domain of urban rail transit "new materials, new equipment, new technology," increasing the difficulty of quality control; he offered to quality control the behavior of the group as a starting point, from the listing method, analysis diagram, figure, configuration of visual expression figure, and quality control, quality control methods, such as systematically analyze and control the construction quality control process, were used. In China, subway construction is invested by the government and managed by state-owned enterprises, among which mechanical and electrical engineering is an important part of

the investment. In terms of the quality management of various engineering projects, after the implementation of total quality management for a period of time, China has gradually shifted to the ISO9000 series of international standards for quality management and quality assurance, and the quality of mechanical and electrical system engineering has gradually improved. With the development of mechanical and electrical engineering, various effective management tools and methods have been widely used in quality control. The management level has been greatly improved, but there are still some problems. For example, the vector control theory of mechanical and electrical engineering is rarely studied from the perspective of the owner, but usually considered from the design and construction units [9].

3. Research Methods and Materials

This part mainly introduces the concept and main calculation process of particle swarm optimization algorithm needed in this paper, as well as the concept of metro wet loess excavation, and the description of metro project quality management; the research method and modeling tools of this paper are introduced.

3.1. Particle Swarm Optimization Algorithm Concept and Process. In 1995, Kennedy and Eberhardt jointly proposed the optimization of this particle swarm [10]. This particle swarm optimization model is based on a random search algorithm that simulates the random foraging behavior of birds in the animal kingdom. It is assumed that the spatial scope of random search is a fixed area of all birds randomly searching for food, and the particle swarm is the individual of these birds searching for these food [11]. In the optimization problem solution, each particle swarm is a random individual in the finite-dimensional search space, and the current position of the particle swarm is the only candidate solution in each optimization problem to be solved. The fitness function is also another metric function, which represents the advantages and disadvantages of all candidate solutions in the problem solution. The process of random flight of particle swarm is the process of random search of random individuals. In particle swarm optimization, the particle velocity is dynamically adjusted according to the best position of the individual's history and the best position of the population. Particle swarm optimization also has two of the most important properties of velocity and position. Velocity is the maximum speed at which a particle travels, and position is the direction in which the particle travels. The speed and position update formula is as follows:

$$V_{m,n}^{t+1} = w \times V_{m,n}^{t} + a_1 \times \text{rand} \times \left(p\text{best}_{m,n}^{t} - x_{m,n}^{t}\right) + a_2 \times \text{rand} \times \left(g\text{best}_{m,n}^{t} - x_{m,n}^{t}\right), \quad (1)$$

$$x_{m,n}^{t+1} = x_{m,n}^{t} + v_{m,n}^{t+1} \times \Delta_t, \quad (2)$$

where w is the inertial weight, which indicates that the particle is proportional to the velocity of the previous iteration, usually between $[0.4, 0.9]$. a_1, a_2 are learning factors, representing the self-learning ability and social learning ability of particles, respectively. Generally, the value is between $[0, 4]$. $x_{m,n}^{t}$, $v_{m,n}^{t}$ is the fitness function, m is n the fitness function t of the best position in the history $p\text{best}_n$ of the first particle, which is the f fitness function of $f(p\text{best}_n)$ the best position in the history of the first $f(g\text{best}_n)$ particle, which is the fitness function of the current best position in the population. rand is a random number between $[0, 1]$ and Δ_t is the change of time, usually 1 [12].

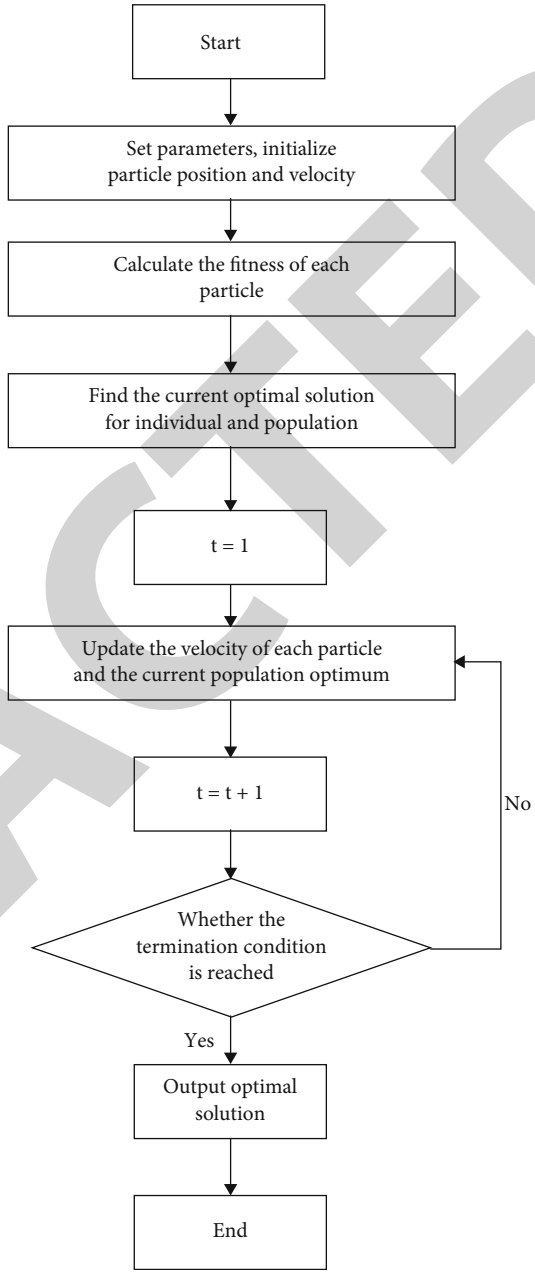

Figure 1: Flow chart of particle swarm optimization algorithm.

Particle swarm optimization flow chart is shown in Figure 1.

3.2. Overview of Wet Loess. Collapsible loess refers to soil of a certain type with uniform soil content, relatively loose structure and special properties with pores [13]. When the rock is

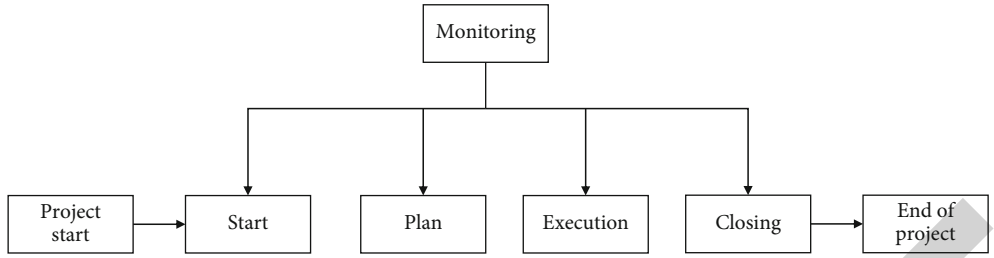

Figure 2: Content of project quality management.

not subject to long time water immersion or not in a long time water completely frozen hardening, the general structural strength requirements are required to be high, and the compressibility is generally poor. When the weathered rock surface structure in the water has a certain proportion of osmotic pressure for the case will be gradually by the pore water fully wet infiltration, the soil structure may therefore occur with rapid water loss and damage and produce a large number of weathered rock additional body and settlement; the strength of the structure will appear more rapid decline. Therefore, in the prevention and control of wet sinking loess sites and other construction of geotechnical engineering construction projects of the building pit support construction technology management links, we should pay attention to the first which should be mainly considered according to the importance of the geotechnical environment of the foundation site of the building; the foundation may be muddy water and wetting and damage to the structure of the potential size and in the actual foundation technology management process should be how to take strict management. Measures and restrictions on the degree of difficulty of construction of the foundation soil are not possible to uniformly and steadily cause settlement; the following comprehensive measures management technical measures to protect and treat and strengthen the foundation to prevent the building foundation settlement on the ground building structure to produce permanent or serious damage to the wet foundation must be followed [14]. In the state of influence of the continuous action of the self-weight stress on the encapsulated soil structure on its foundation, or at the same time due to its influence of other continuous self-weight stress conditions and apparent continuous additional deformation stress continuous action conditions, the soil structure after immersion does not suffer continuous damage deformation effect and also is not obviously produced by other apparent continuous and additional deformation stress continuous deformation conditions which influence its effect. A structural soil is also called continuous wet sink soil, which is one of the special structural soils. Some miscellaneous soils may also have the same kind of wet subsidence sometimes. In China, there are some loess areas with wet sink properties in the northeast, northwest, central region, and the eastern part of the south slope of Sichuan Province, which are widely distributed in the area. Wet sink loess can be divided into completely semi-self-weighted wet sink loess and partly completely semi-self-weighted wet sink loess; part of the older loess is also transformed into part of the unstable wet sink loess. The more dominant variety of loess particle components contained in our wet-sediment loess is coarse powder particles, which accounts for about 50-70% of the proportion of each component to the average total weight percentage of the total mass of particles of all our wet-sediment loess containing materials. 0.1 mm is coarse spodumene particles, about each accounting for about 40.60% of the average weight of its total spodumene particles. 0.05 mm clay grains were less, accounting for about 14.28% of the total weight. The weight of 1 mm fine sand grains was less than 5% of the total weight of the 25 mm medium sand particles. The particle size of the wet sinking loess gradually decreases from northwest to southeast [15].

3.3. Overview of Project Quality Control

3.3.1. Content of Project Quality Management. As an important part of project management, project quality management plays a decisive role in project quality. Project quality management can be divided into enterprise quality management and product quality management, and product quality management must meet the ultimate needs of users [16]. Project management is generally divided into five parts, which are project initiation, project planning, project implementation, project closure, and project monitoring. Project monitoring is in the first four parts to ensure the quality standard of the project from the work of each part, the content of project quality management, as shown in Figure 2.

3.3.2. The Meaning and Framework of Quality Management. Quality management can guide a company in quality planning, quality control, quality assurance, and quality improvement; definition, quality policy, objectives and responsibilities, quality system planning, control, assurance, and improvement are all part of quality management [17]. Throughout the quality management system, it requires the rational organization and management of all aspects of the bank such as planning, personnel, finance, equipment, and environmental protection. After the quality policy is issued by the management, the organization determines the quality objectives and builds a quality management system based on the basic principles of quality management, using a combination of standardized methods and ensuring the necessary human and material resources to carry out quality management activities. In this process, necessary incentives can be used to encourage employees to participate in quality planning, quality control, quality assurance, and quality improvement work in an orderly manner. Quality command and control activities mainly include the development of

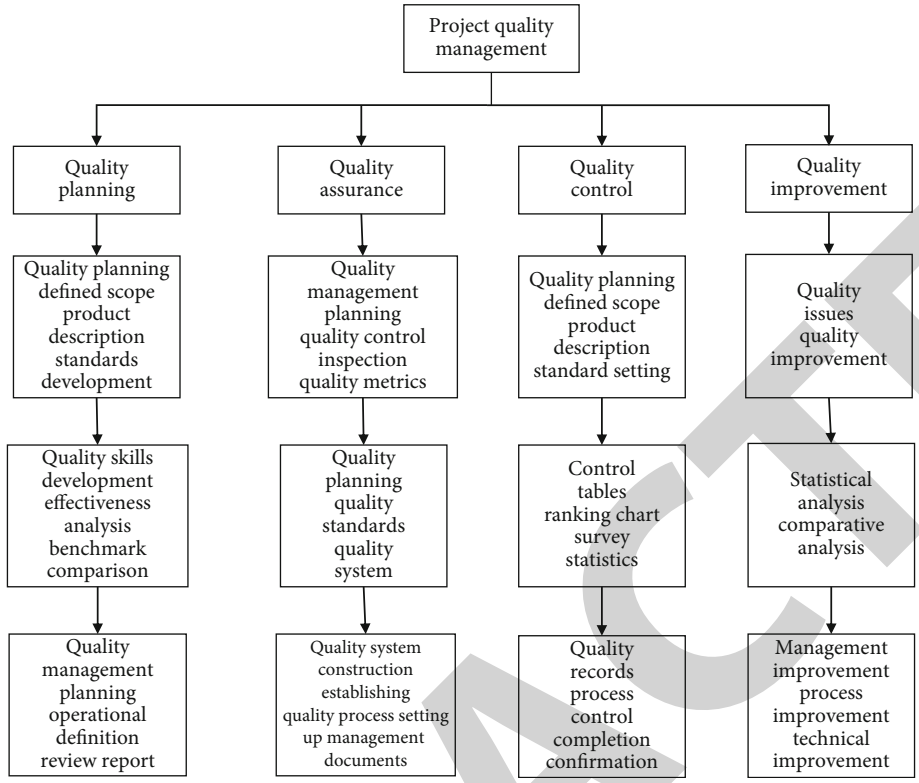

Figure 3: Framework of project quality management.

quality policy and quality objectives and the implementation of quality planning, quality control, quality assurance, and quality improvement. Quality policy is the quality principle and direction of leadership learning, is the guideline of all aspects of quality management, is the performance of leadership quality consciousness, and reflects the quality management objectives and quality culture of the enterprise. Quality objectives are formulated according to the quality policy, which meets the requirements of quality aspects and the requirements and pursuits of continuous improvement of quality management system, and quality objectives are quantitative and can be tested [18]. Quality planning is an indispensable intermediate part of the quality management process. In order to achieve quality objectives, implementation links and resources must be established, including management and work planning, quality planning, and quality assurance measures. Quality control is the process of quality control using certain operational techniques and activities to meet the quality requirements of the product or service, in which the design of the quality control system and the selection of quality control techniques are very important, and in this case, if new factors appear, the causes should be analyzed and corrected in time to form a closed management process [19]. Quality assurance is the implementation of planned and systematic measures in the management system to make the user trust the final product or service to meet the predefined quality requirements. Quality assurance is not fully understood as quality assurance; it is quality control based on quality assurance, so that the user fully "trusts" the quality. Based on the quality control and quality assurance aspects, current problems and deficiencies are analyzed and effective measures are taken to improve quality [20]. The framework of project quality management is shown in Figure 3.

3.4. Research Methods and Tools. In this paper, we mainly use particle swarm optimization algorithm to systematically analyze the relationship between the three major elements of metro project duration, cost, and management and the construction and quality control of wet loess in concealed tunnel of metro. The main algorithm formulas and elements used are as follows:

$$V_{m,n}^{t+1} = w \times V_{m,n}^{t} + a_1 \times \text{rand} \times \left(p\text{best}_{m,n}^{t} - x_{m,n}^{t}\right) + a_2 \times \text{rand} \times \left(g\text{best}_{m,n}^{t} - x_{m,n}^{t}\right), x_{m,n}^{t+1} = x_{m,n}^{t} + v_{m,n}^{t+1} \times \Delta_t. \tag{3}$$

The two formulas here have been described in detail in the above particle swarm optimization algorithm, so without further comment; this formula is used for analysis and discussion in this paper.

The main tool used is MATLAB software for programming and algorithm program design, and this software has the following advantages:

(1) Efficient and flexible numerical simulation calculation methods and numerical symbolic calculation

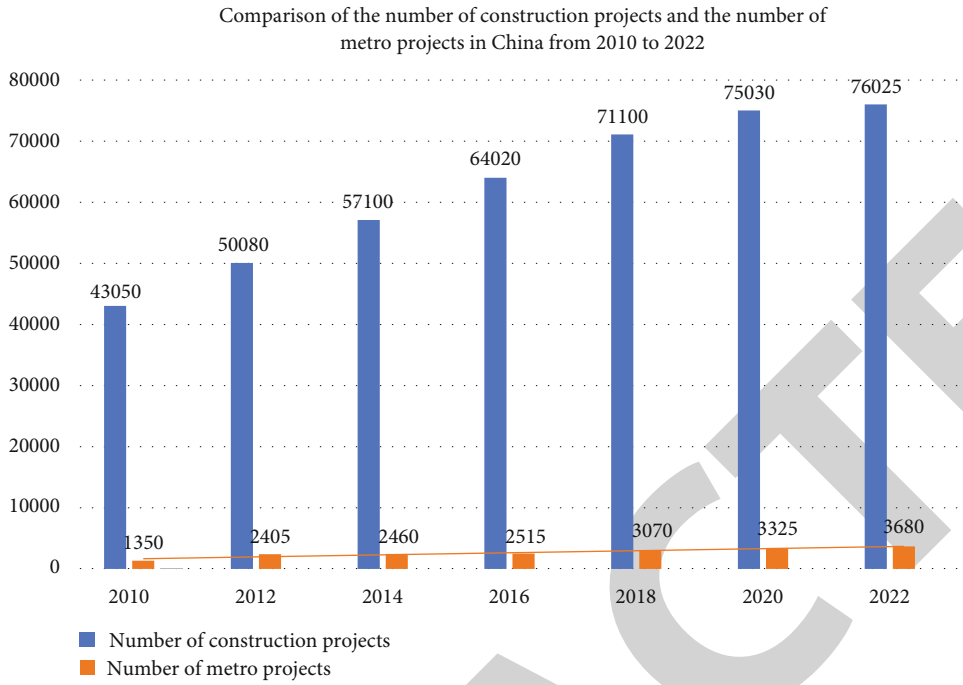

Figure 4: Comparison of the number of construction projects and the number of subway projects in China from 2010 to 2022.

conversion function can easily enable users to completely get rid of the heavy and complex and boring basic mathematical symbolic calculation design and application analysis

(2) A complete and practical set of computer graphics output processing platform functions, realizing the graphic visualization modeling and visual programming processing of calculation and result processing

(3) Friendly interface and natural language close to mathematical expressions, which is easy for scholars to learn and master

(4) In the more complex and rich and diverse functional structure of various comprehensive application system toolbox series software (such as signal processing toolbox and communication toolbox) products, to solve the problem of various system user needs to provide the development of the design of a large number of functions with convenient and practical characteristics of the system application processing tools

4. Results and Discussion

In this part, based on the research of the basic principle of quantum grain group optimization calculation and the realization of engineering key technology in the third part, auxiliary MATLAB software, the main analysis of the construction and quality control of wet loess in concealed tunnel of metro project, mainly through the relationship between the three major elements of metro project duration, cost, and management and the construction and quality control of wet loess concealed tunnel of metro, a systematic analysis and The results are discussed in the following points.

4.1. Experimental Results. A city rail transit line 1 is located in the main north-south passenger corridor of city A. It connects the high-speed railway north station, city square, city center, provincial stadium, commercial and cultural center, international exhibition center, and large passenger hub. 22 passenger stations are designed in the overall planning, including 6 interchange stations and 2 starting and ending stations. Railway line 2 and line 1 form a cross-shaped skeleton in the railway network: 2021 August 10, the construction period of five years, the planned investment amount of 500 million yuan.

(1) With the rapid development of China's economy, the construction of infrastructure is in full swing, and the construction scale of subway projects is also gradually expanding; as China's main urban transportation now, people's demand for subway projects is increasing, the number of construction projects in China in 2010 is 43050, including the number of subway construction 1350, the number of construction projects in 2012 is 500800, the number of subway construction 2405, in 2014 China's construction projects 57100, subway construction projects 2460, to 2022 China's total number of construction projects 76025, the number of subway construction 3680, it can be seen that both construction projects and subway construction projects are growing year by year, where the subway construction projects in the total construction engineering projects also occupies a considerable proportion, as shown in Figure 4

(2) With the increase of construction projects and metro construction, engineering accidents also occur

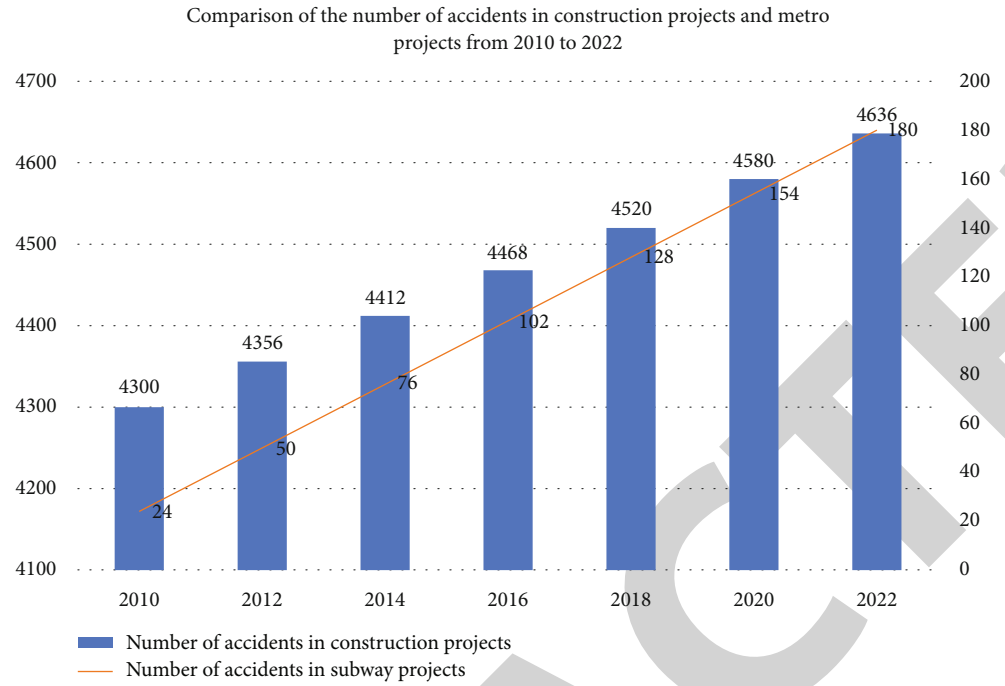

Figure 5: 2010-2022 China's construction projects and metro project accident volume comparison chart.

frequently, so it is necessary to focus on the quality of metro construction to avoid quality and safety accidents. As seen from the figure, the total number of accidents occurred in China's construction projects in 2010 was 4300, and the number of quality accidents occurred in metro construction projects was 24. In 2012, the number of accidents occurred in China's construction projects 4356, the number of accidents occurred in subway construction projects 50, in 2014, the number of accidents occurred in China's construction projects 4414, the number of subway construction projects 76, to 2022, the number of accidents occurred in China's construction projects 4636, the number of subway construction projects 180, it can be seen that with the construction projects in China increase, the construction project engineering safety index has decreased, the number of safety accidents has increased year by year, as the construction project of the subway construction project, construction accidents are also showing only an increase in the trend. Therefore, the quality and safety control of subway construction is especially important and must be given great attention, as shown in Figure 5

(3) The quality of the metro project and the requirements of the project duration are inseparable, purely considering only the requirements of the duration, if the requirements of the duration are urgent, the construction party may be to sacrifice the quality of the project to catch up with the schedule, this paragraph takes an idealized analysis, purely considering only the factors affecting the duration, to find the effect of the duration on the quality of the project. Assuming that the ideal construction period of the subway project is 5 years, the algorithm and modeling software are used to carry out the ideal modeling: if all aspects of the project proceed smoothly and the construction period is 5 years, the project quality is qualified. Through the algorithm and software to shorten and increase the construction period, the following conclusions are drawn: if the construction period is shortened to 4.5 years, the probability of engineering quality accident is 97%; if the construction period is shortened to 4.6 years, the probability of engineering accident is 94%; if the construction period is shortened to 4.7 years, the probability of engineering quality accident is 91%. If the construction period is shortened to 4.9 years, the probability of quality accidents is 85%. It can be seen that the more the ideal construction period is shortened, the higher the probability of quality problems will occur. Therefore, attention should be paid to the control of the construction period in the construction and control to a reasonable range, as shown in Figure 6

(4) The quality of the project is also closely related to the cost, assuming the subway construction project construction cost is 450 million RMB, under all conditions in the idealistic state, all the cost for the subway construction, the subway construction project of the accident probability is 0, and the algorithm and software

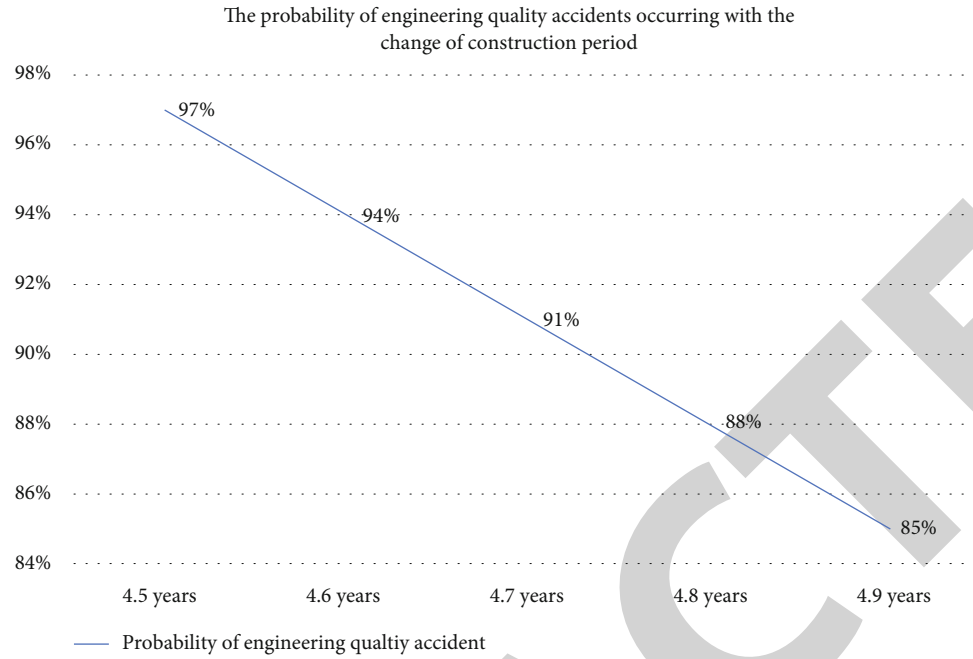

Figure 6: Probability of engineering quality accidents with time limit.

rationalization analysis: Assuming that when the cost of the subway project is reduced from 450 million to 440 million, the probability of subway quality accidents is 89%, 91%, 93%, 95%, and 97%, respectively. Cost reduction will also lead to the decline of engineering quality, easy to cause engineering quality problems, as shown in Figure 7

(5) Quality is closely related to the project management of the project, the assumption that the subway project management personnel 20 people, the project quality problems of probability is 0, the algorithm and software modeling analysis, management personnel number dropped to 18 people, the quality of the accident probability is 97%, managers down to 16 people, and the accident probability is 95%. When the number of managerial personnel decreases to 14, the accident probability is 87%; when the number of managerial personnel decreases to 12, the accident probability is 85%; when the number of managerial personnel decreases to 10, the accident probability is 80%. It can be seen that the number of managerial personnel also has an important impact on subway quality accidents and can not arbitrarily reduce the number of managers, save money, as shown in Figure 8

(6) From the above analysis, it can be seen that the safety and quality accidents of subway construction projects are closely related to the construction period, cost, and number of management personnel, with construction period accounting for 31.5%, cost 35.2% and number of management personnel 33.3% as shown in Figure 9

4.2. Analysis and Discussion. In recent years, due to the poor quality of subway tunnel construction, tunnel collapse, leakage, and other problems are increasingly serious, not only causing economic losses but also affecting the construction progress of subway tunnel. Therefore, it is necessary to strengthen the research on the key technology of subway tunnel construction quality control, master the key technology of subway tunnel construction quality control, and ensure the safety of personnel and the quality of subway tunnel construction. The staff of subway tunnel construction project should improve their quality consciousness, master a lot of key quality control techniques, and promote the smooth development of subway tunnel construction project.

Construction quality control plays an important role in the process of subway tunnel construction. Practice has proved that in the process of the subway tunnel construction, a thorough inspection to the construction environment, the construction unit should strictly control the construction quality of each link, formulate relevant rules and regulations, and make clear a regulation, to ensure the implementation of construction personnel in the process of the subway tunnel construction; the construction risk is higher, the various forms and effect of tunnel support should be paid attention to in order to improve the construction safety of the tunnel and ensure the safety of persons and property. Construction quality control needs to be strengthened. First, the construction unit is responsible for the management of supporting materials, strengthen the quality

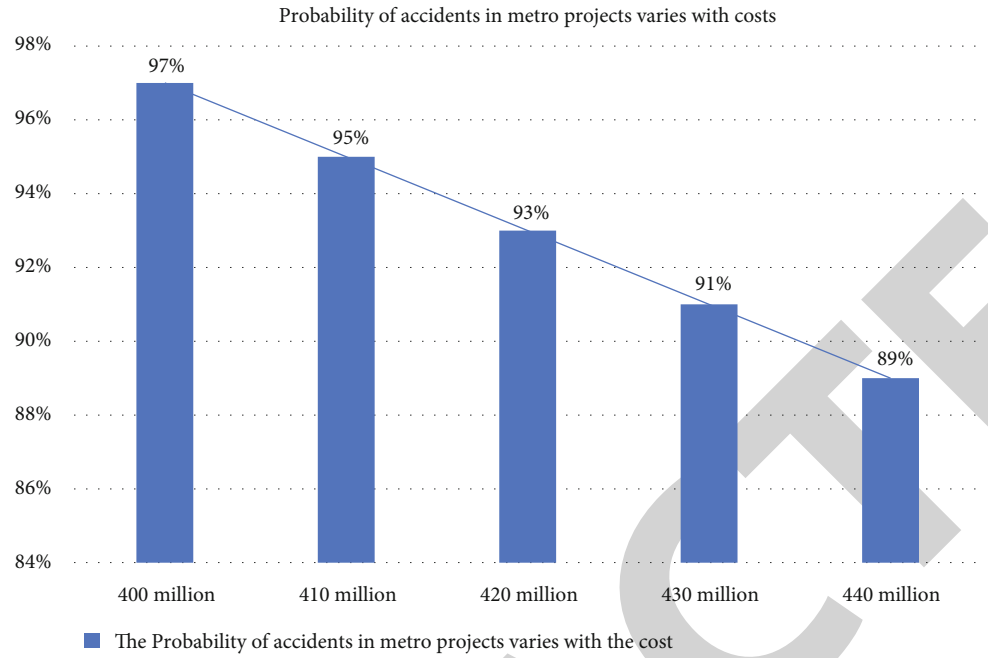

Figure 7: The variation of accident probability of subway project with cost.

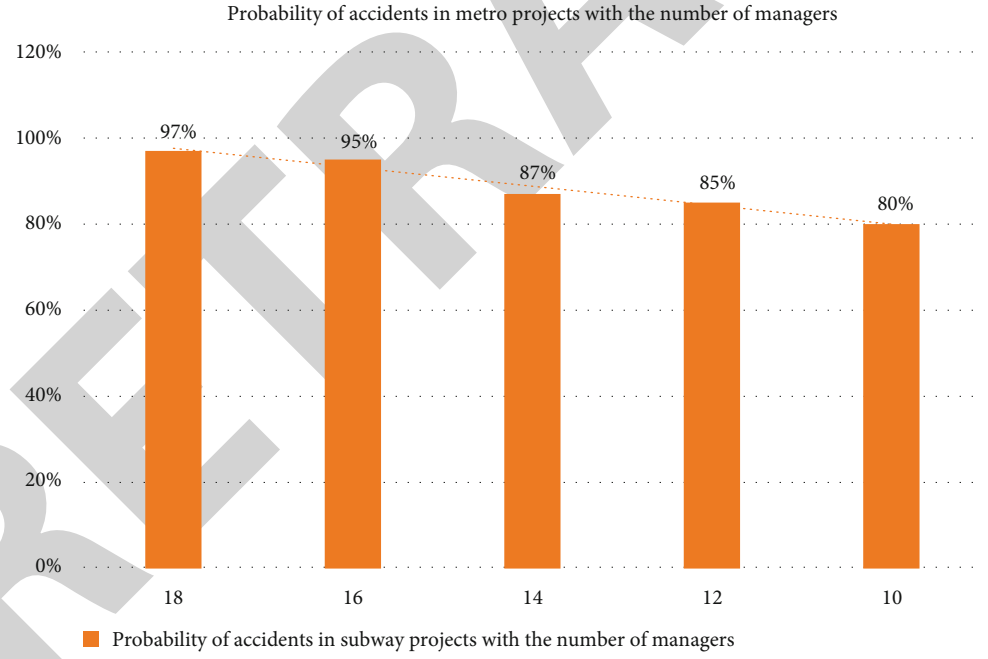

Figure 8: The variation of accident probability of subway project with the number of management personnel.

control of materials, and pay special attention to the inspection after use. The second is to use reinforcement support technology, try cold drawing solidification, check the quality of reinforcement in pavement construction, and transport the reinforcement to the construction site, to ensure that the flatness of reinforcement meets the requirements. The construction quality of concrete must be well controlled. In the construction of the inner wall, we should pay close attention to the height of concrete, so that concrete performance indicators meet the design requirements. The surface of concrete is smooth, without cracks, back tendons, reducing voids, etc. In order to make the geometric parameters of concrete arc section meet the structural requirements, it is necessary to measure the corresponding height of the base. Therefore, more inverted foundations can be poured during construction.

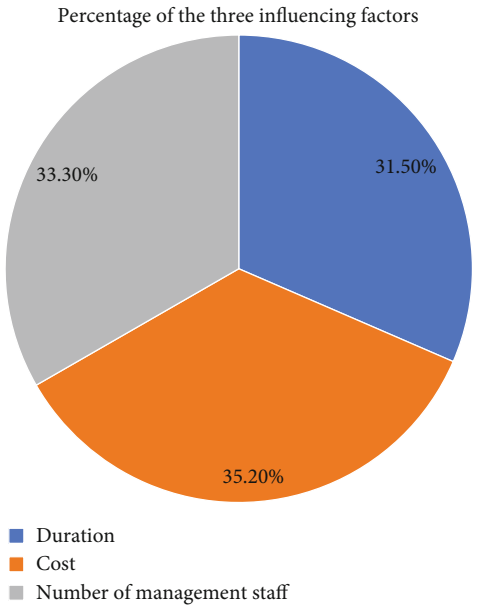

Figure 9: Proportion of construction period, cost, and number of management personnel.

Construction quality control is one of the important tasks of quality management, throughout the whole process of project decision-making and implementation, and in each link according to the quality requirements, strict control, in order to build a high standard, high-quality, efficient construction project. According to the quality management system of the construction enterprise and the overall quality control system of the project of the construction unit, as well as the relevant provisions and requirements of the design unit, a quality assurance ability system of geotechnical engineering professional construction enterprises is established, which takes the construction and management organization management of the construction site as the main task. The establishment of the implementation of quality excellence development goal system, quality control department functions, and its division of labor, quality control, management and other basic system provisions and management of the basic process, construction organization quality planning program and project construction organization design documents, quality control point system and its related control and measures, internal and external management communication and mechanism system and its control operation management measures. Quality certification management process system in the engineering operation process should follow a strict follow the PDCA cycle, plan (plan, stage), do (implementation stage), check (check) steps and action (process stage) steps process principles, through systematic planning and analysis and actual engineering operation practice, to strengthen the source of quality problems management, carry out preconstruction plan and identification of quality common disease factors, through the identification of the factors influencing the quality common problems before construction decomposes the control measures one by one, determines reasonable construction procedures, construction techniques, and technical measures by formulating construction quality control plans, strengthens the inspection of design drawings, especially the buried pipes prone to collision, calculates and checks their spatial locations, makes full use of advanced technologies such as BM technology, transforms two-dimensional drawings into four-dimensional models of buildings, carries out visual disclosure and collision inspection, solidify the technical foundation of construction, identify drawing design problems and optimize improvement in advance, while avoiding hidden quality problems caused by blind construction by construction personnel.

Establish a clear, definite, reward and punishment quality management system, with each division performing its own duties and responsibilities, organized in an orderly manner, setting the project manager as team leader, project director and project production manager as deputy team leaders, and construction, technology, quality inspection, measurement, materials, testing and other departments closely cooperated by the quality management team and supervisory personnel, forming a strong quality assurance system; strengthen the quality supervision and law enforcement of grassroots construction projects force, seriously investigate and deal with all kinds of illegal and irregular acts, and resolutely stop the disorderly transformation of rural houses and public buildings to avoid engineering quality problems and hidden dangers to people's lives and safety.

Industrial workers are the main force of the working class, the backbone of creating social wealth, the backbone of innovation-driven development, and the effective force in implementing the strategy of manufacturing power. Housing and urban-rural construction departments should accelerate the reform of industrial workers mechanism, education departments should vigorously promote the reform of technical schools, and construction enterprises should establish industrial workers training schools to provide specialized training for industrial workers, such as welders, electricians, production workers, assembly workers, preburied workers, grouting workers, and plasterers, through internal training or outsourcing training. Support high-quality development of construction projects based on industrial workers.

Vigorously promote assembly-type construction green building, the use of information technology, standardization, industrialization, assembly technology to replace the traditional cast-in-place mode, the use of modern construction technology can effectively reduce the quality of site operation of uncontrollable quality, environmental uncontrollable, uncontrollable personnel and other factors on the quality of industrial construction, information management, commercialization sales model to improve the quality of the project. The development of green building is China's construction industry in the context of carbon peak and carbon neutral must take the green development path, actively guide the emerging construction industry and intelligent building-related technology fields, joint construction units and design units to carry out the application of assembly-type buildings and green building demonstration projects.

Building construction enterprises should establish quality management-related systems and realize the management of people, machines, materials, methods, environment, and measurement, while adopting a comprehensive management

model to realize quality process management; actively apply new technologies such as Internet plus, artificial intelligence, etc.; vigorously promote the industrialization and industrialization of construction projects; and promote the transformation of China's construction projects to the direction of refinement, digitalization, and intelligence.

5. Conclusion

In this paper, based on the in-depth study of the basic principle of quantum particle swarm optimization calculation and the realization of key engineering technologies, the particle swarm optimization algorithm was programed using MATLAB software, and the coding scheme, operation specification, and operation parameters were designed. Then, combined with the particle swarm optimization algorithm, auxiliary MATLAB software, the main analysis of the construction and quality control of the wet loess concealed tunnel of the subway project, mainly through the relationship between the three major elements of the subway project schedule, cost, management and the construction and quality control of the wet loess concealed tunnel of the subway, a systematic analysis was made, and the following conclusions were drawn.

(1) Stable schedule: to ensure the construction and quality control of subway wet loess in concealed tunnel construction, it is necessary to ensure that the construction schedule of the project is stable. Through measurement and analysis, if the schedule is advanced, what may be caused is the appearance of the project in order to catch up with the schedule to cut corners, thus causing the corresponding quality problems

(2) Sufficient cost budget: cost and the quality of the project is closely related to the subway wet loess dark excavation tunnel construction and quality control requirements must have sufficient budget costs, in order to ensure that there are sufficient financial resources to purchase materials, to ensure that the project is not because of the cost of compression to cut corners, thus ensuring the quality of the project

(3) Sufficient number of managers: to ensure the construction and quality of the subway wet loess concealed tunnel construction and at the same time need to have sufficient management personnel, because the quality of the project and management are inseparable, sufficient management personnel, can be in all aspects of the project, the project control, reduce the risk factor of the project

In conclusion, this paper based on the particle swarm optimization algorithm of subway wet loess in concealed tunnel construction and quality control, through algorithm and theoretical analysis, concluded that the project duration, cost, and management is extremely important to the subway wet loess in concealed tunnel construction and quality control.

Data Availability

The dataset is available upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Retraction

Retracted: Modal Analysis of Aeronautic Spiral Bevel Gear in the Temperature Field

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] W. Yu, S. Liu, W. Xu, and D. Wang, "Modal Analysis of Aeronautic Spiral Bevel Gear in the Temperature Field," *Journal of Sensors*, vol. 2022, Article ID 1707808, 13 pages, 2022.

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Research Article

Modal Analysis of Aeronautic Spiral Bevel Gear in the Temperature Field

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The temperature of the bevel gear tooth surface will increase greatly because of its special structure. Modal is the characteristic of reaction structure. In order to design and manufacture higher quality aerial bevel gears, it is necessary to study the modal of aerial bevel gears under the action of the temperature field. Firstly, a temperature field calculation model is established according to heat transfer theory. Then, based on the traditional linear modal theory, the modal analysis model under the influence of temperature was established considering the influence of rotational speed and temperature field on the stiffness. Based on the model, modal analysis of the driven gear of a certain aviation bevel gear is carried out. It can be seen from the analysis results that the speed has a great influence on the gear stiffness, and the positive and negative effects are related to the direction of the centrifugal force. Secondly, the inhomogeneity of temperature field distribution also affects the natural frequency and then the gear stiffness. When the speed field and temperature field work together, the pitch shape changes the most, so it is necessary to consider temperature as an influencing factor in the design of aerial bevel gears.

1. Introduction

Bevel gears are widely used in the helicopter transmission system and aeroengine for main deceleration and change of transmission direction. Compared with other industries, bevel gears should have high bearing capacity, small volume mass, high reliability, and smooth operation at high speed. Bevel gears are the indispensable key parts of helicopter transmission and engine, and their dynamic performance will directly affect the working condition of a helicopter. The aviation bevel gear has the characteristics of high overload, and due to the restrictions of the main reducer or aviation engine, its normal work under the condition of lubrication situation is relatively poor, often in the lack of oil lubrication state, so in the work produced by friction and heat flux, larger heat transfer to the environment and can be collected and cause tooth surface temperature increasing significantly. Then, there will be gluing and other gear failures. Structural modal is often used to reflect the physical characteristics of the structure, and the modal analysis of gear is through the analysis of the inherent characteristics of gear (frequency, damping, and modal). Studying the structural characteristics of the gear process purpose is to identify the modal parameters of the gear pair, for gear dynamic vibration characteristic analysis, and provides the reference for the optimization of structural dynamic characteristics. Therefore, it is necessary to study the modal changes of aerial bevel gears under the action of the temperature field.

At present, the modal analysis of gear mainly includes gear and gearbox, among which the modal analysis of gear parts is mainly involute gear such as spur gear or helical gear, and the modal analysis of bevel gear is less literature. Ben and Lin [1] performed a dynamic modal study of the vehicle's rear axle gears and claimed that high-speed gears have a "centrifugal rigidization effect" owing to centrifugal motion. Based on the resonance theory, Duo [2] constructed a modal and performed resonant analysis on spiral bevel gears in high-speed and heavy-duty conditions. Renyan [3] does a modal analysis of a spiral bevel gear, obtaining the inherent frequency and vibration type of the gears and verifying the resonance of the high-speed gear system. Haiguo

and Bin [4] used APDL to create a finite element model of the whole structure of the spiral bevel gear. The model estimated the inherent characteristics of 5 gears with varying abdominal plate thicknesses, and the low-order vibration type is summarized on this basis. In order to avoid damage to gear pump parts caused by resonance, Guo and Haiming [5] used ANSYS to analyze its modal analysis and made statistics and analysis of the first 10 order modal of the used parts. Kaihong et al. [6] applied ABAQUS to analyze the modal forms and natural frequencies of elliptical gears according to the elastic theory and verified the analysis results by comparison in experiments. Li [7] used the ANSYS asymmetric gear to conduct modal analysis to verify the correctness of his derivation of the transient stiffness of asymmetric gear.

In terms of temperature field research of bevel gears, Handschuh and Kicher [8] first proposed a three-dimensional modeling method to analyze the thermal behavior of spiral bevel gears. Yunwen et al. [9] proposed a mathematical model for calculating the body temperature of spiral bevel gears based on heat transfer theory. Zhang et al. [10] studied the tooth surface temperature rise of spiral bevel gears based on the elastohydrodynamic theory and improved the thermal analysis method on this basis. Zongzheng Wang et al. [11] studied the temperature field of different contact traces based on elastohydrodynamic theory. Based on heat transfer and tribology theories, Fei et al. [12] analyzed the transient temperature field of the spiral bevel gear in the helicopter transmission system under the condition of lack of oil and obtained the calculation method of the transient temperature field under this condition. Shi et al. [13] used the finite element method to establish the temperature field model of the gear body and analyzed the steady temperature distribution law of gear teeth after obtaining the steady temperature field of locomotive traction gear. Li and Pang [14] carried out various load tests on the gear system with split teeth through finite element simulation and found the variation rule of the temperature field in the tooth domain around the split teeth under different load conditions. Li and Tian [15] studied the three-dimensional analysis and temperature sensitivity analysis of the unsteady temperature field of gear transmission, in which the frictional heat causes the rise of surface temperature and reduces its bearing capacity and antiglue capacity. Xue and Xu [16] use the finite element simulation method to calculate and analyze the influence of different oiling and large spiral bevel gear steering on the temperature field distribution of the gearbox for the cross monorail train.

Currently, Yuning et al. [17] employ the Monte Carlo approach to investigate the effect of material parameter changes produced by temperature field changes on the intrinsic frequency, despite the fact that the temperature field has less influence on the modal state. In this regard, the investigation of geometrically more complicated curved spiral bevel gears is rarely described.

In this paper, the temperature field distribution model is firstly established according to the energy equation. Based on the linear modal theory, combining the temperature field distribution model with the stress, the modal equation of the aviation bevel gear under the action of the temperature field is established. Then, on this basis, the numerical calculation method is used to solve the natural characteristics of the driven gear of an aviation bevel gear. According to the numerical calculation results, the variation of the mode of the aviation bevel gear under the single or joint action of the speed field and temperature field is obtained, and its influence is analyzed.

1.1. Temperature Field Distribution Model. Since the change of temperature will produce additional stress stiffness, the temperature field distribution of the gear tooth should be determined first before the modal analysis. The working temperature of gear is mainly composed of two parts: the body temperature of gear and the instantaneous temperature (or flash temperature) of the meshing tooth surface. According to Reference [18], body temperature is the main influencing factor of gear thermal deformation [18]. Under the condition of constant speed and load, although the instantaneous temperature of the meshing tooth surface changes in the process of gear rotation, the influence range is small and the duration is short. Therefore, it is generally assumed that the temperature of each point on the gear does not change with time; that is, the temperature field of the gear tooth body is treated as a stable temperature field. At present, the finite difference method and finite element method are commonly used to study the temperature field of the gear body. For the tooth surface model with a complex shape, the stability of the finite difference method is poor [19]. Therefore, the finite element method is used to analyze the temperature field in this paper.

1.2. Temperature Field Calculation Model. According to the law of energy conservation, the heat transfer differential equation of the three-dimensional transient temperature field is obtained:

$$\frac{\partial T}{\partial t} = \frac{\kappa_g}{\rho_g C_g}\left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial x^2} + \frac{q_0}{\kappa_g}\right), \tag{1}$$

where T is the body temperature of gear teeth, κ_g is the thermal conductivity of the material, ρ_g is the material density, C_g is the specific heat capacity of material, and q_0 is the intensity of the heat source in the material.

First, it is assumed that there is no internal heat source in the steady-state temperature field, that is, $q_0 = 0$. Secondly, in the steady-state condition, the temperature field no longer changes with time T, $\partial T/\partial t = 0$. Therefore, the heat transfer differential equation of the three-dimensional steady temperature field is

$$\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial x^2} = 0. \tag{2}$$

1.3. The Boundary Condition of the Steady-State Temperature Field Thermal Analysis Boundary. To solve Equation (10), additional boundary conditions and initial conditions are required. There are three types of common

boundary conditions [18]: The first type is the temperature or temperature function of the known boundary. The second boundary condition is the heat flow on the boundary of the known object. The third type of boundary condition is the known temperature and convective heat transfer coefficient of the medium in contact with the solid.

The temperature field boundary condition of spiral bevel gear is the following:

(1) *Meshing Tooth Surface*. There is a heat source generated by meshing friction on the meshing tooth surface. Therefore, it is the third type of boundary condition with a surface heat source:

$$-\kappa_g \frac{\partial T}{\partial n} = \alpha_1 (T - T_0) - Q \tag{3}$$

(2) *Top, Root, and Nonengaged Surface*. For the third type of boundary conditions:

$$-\kappa_g \frac{\partial T}{\partial n} = \alpha_2 (T - T_0) \tag{4}$$

(3) *Gear Tooth Face*. For the third type of boundary conditions:

$$-\kappa_g \frac{\partial T}{\partial n} = \alpha_3 (T - T_0) \tag{5}$$

In Equations (3)–(5), n is the external normal direction of the meshing surface, T_0 is the working temperature of the medium, Q is the average frictional heat flow, α_1 is the convective heat transfer coefficient of the meshing surface, α_2 is the convective heat transfer coefficient of the tooth tip, tooth root, and nonmeshing surface, and α_3 is the convective heat transfer coefficient of gear teeth. The temperature of the other surfaces varies little with the normal direction and can be regarded as $\partial T/\partial n = 0$.

1.4. The Amount of Heat Flow That Engages the Flank. There are three main types of friction between meshing tooth surfaces: sliding friction, rolling friction, and internal friction caused by metal elastic-plastic deformation. At high speed, due to geometric reasons, the tooth surface of spiral bevel gears has a relatively large sliding speed. Therefore, rolling friction and internal friction are ignored, and only sliding friction is considered. The influence factors of friction heat produced by sliding friction are related to the normal pressure and friction coefficient besides the relative sliding velocity. The frictional heat flow per unit time and per unit area due to the relative sliding of the tooth surface is [20]

$$q_c = \eta p_{nc} \mu v_s, \tag{6}$$

where q_c is the heat flow of meshing tooth surface; η is the thermal conversion coefficient; p_{nc} is the normal contact pressure, generally Hertz stress; μ is the coefficient of friction; and v_s is the relative sliding speed.

Frictional heat is assigned to the two flanks of the active gear and the passive gear, so that the heat distribution coefficient of the active gear, then β is the frictional heat flow of the active gear and the passive gear q_{1c}, which is q_{2c} [20]:

$$\begin{cases} q_{1c} = \beta q_c, \\ q_{2c} = (1 - \beta) q_c. \end{cases} \tag{7}$$

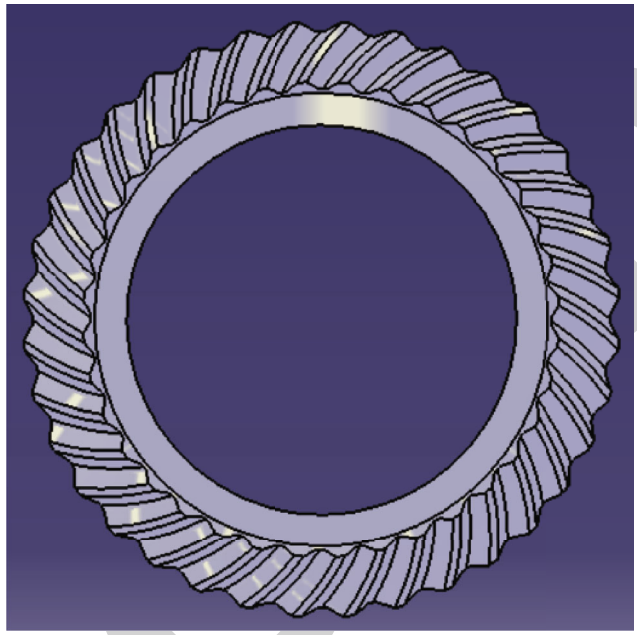


Figure 1: 3D model of spiral bevel gear.

Table 1: Convective heat transfer coefficient of each part of gear teeth [8].

The surface position	Convection heat transfer coefficient (W/(m^2∗°C))
Meshing nonworking face	4450
Tooth top and alveolar surface	50
The small end face	50
Large end face	160
The other side	160
Meshing nonworking face	0

Table 2: Thermal analysis of different mesh densities.

Grid density	Maximum temperature (°C)	The number of grids
2	281.7	187322
3	281.06	65454
4	281.22	39570
5	281.54	24760

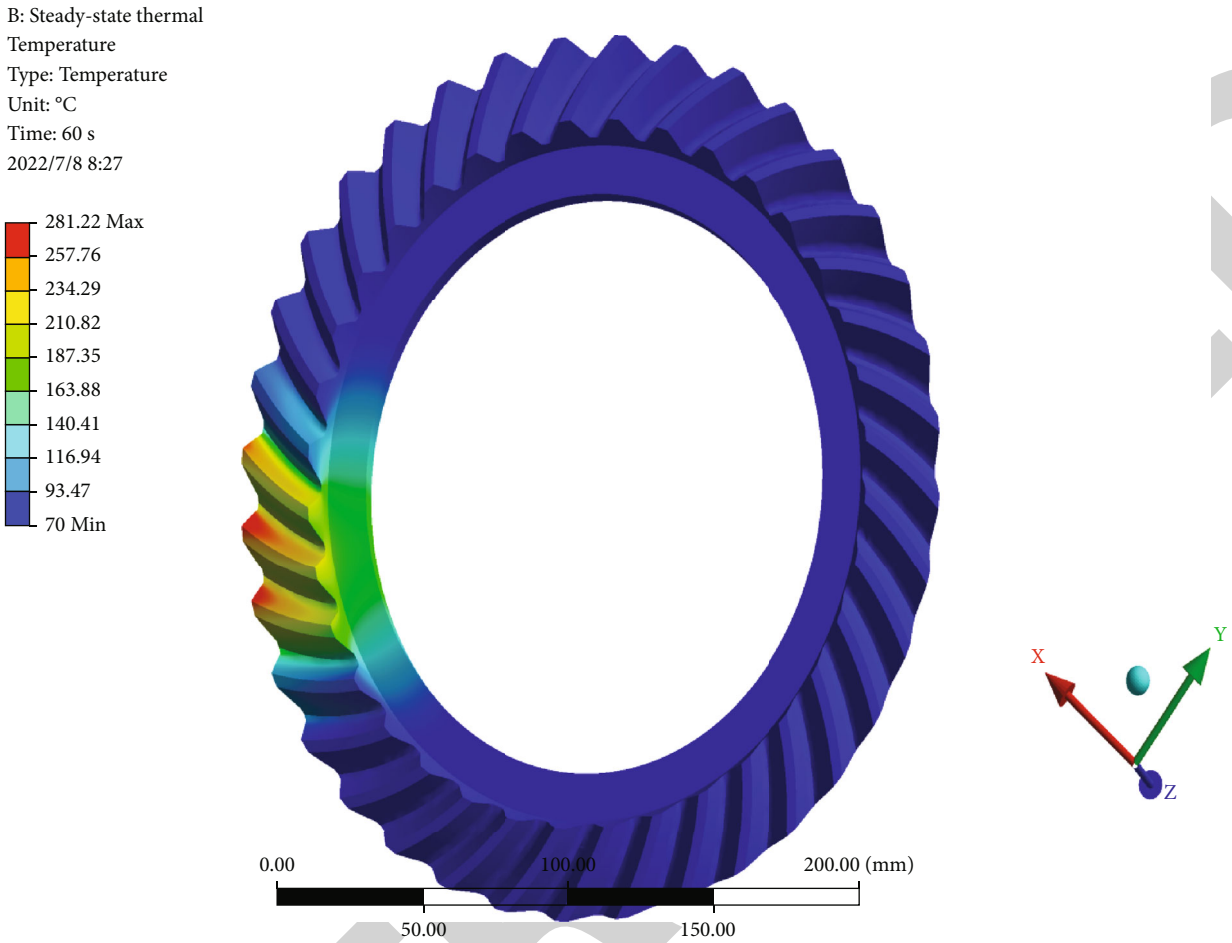


Figure 2: Temperature field distribution calculated by steady-state thermal analysis.

Because the material of the active gear and the passive gear is the same, in order to solve this paper differently from the numerical, $\beta = 0.5$.

During the whole transmission process, the heat flow at the meshing point will keep circulating input with its rotation [21]. Therefore, in order to facilitate the calculation and take the average value, the driving gear and driven gear rotate for 1 cycle, and the average friction heat flow is

$$\begin{cases} q_1 = \dfrac{b}{v_{t1}} \dfrac{n_1}{60} q_{1c}, \\ q_2 = \dfrac{b}{v_{t2}} \dfrac{n_2}{60} q_{2c}, \end{cases} \tag{8}$$

where b is the contact width; v_{t1}, v_{t2} are the tangential speed of the pinion and wheel gear; and $n_1 n_2$ are the rotary speed of the pinion and wheel gear.

1.5. Calculate the Convection Heat Exchange Coefficient. According to Section 1.2, the accuracy of the convective heat transfer coefficient directly affects the calculation accuracy of the temperature field. Because of the complex geometry of spiral bevel gears and the different cooling and lubrication methods, the heat transfer coefficients of each part are quite different. For the convenience of numerical calculation, they are divided into three categories: heat transfer coefficient of end face, heat transfer coefficient of meshing surface, and convective heat transfer coefficient of tooth tip, tooth root, and nonmeshing surface.

Compared with spur gears, the geometric shape of spiral bevel gears is more complex. Therefore, the method in Reference [21] can be adopted to simplify the gear into a rotating conical disc, and the end face is a rotating conical surface. After simplification, the convective heat transfer coefficient α_3 of the spiral bevel gear face is calculated as [21]

$$\alpha_3 = N_u \kappa_g \left(\frac{n_i \pi}{30 \nu \sin(\delta_a/2)} \right)^{0.5}, \tag{9}$$

where κ_g is the thermal conductivity, $n_i (i = 1, 2)$ is the pinion or wheel gear speed, ν is dynamic viscosity of lubricating oil, δ_a is the spiral bevel gear surface cone angle, and N_u is the Nuschelt number, which is related to the surface fluid flow state.

When Reynolds number $\mathrm{Re} < 2 \sim 2.5 \times 10^4$, the fluid near the tooth surface is in a laminar flow state, and the Nusselt number is independent of R_e [18]:

$$N_u = 2\left(\frac{1.02P_r(m+2)}{60}\right)^{1/3}. \quad (10)$$

When $\mathrm{Re} > 2.5 \times 10^4$, the surface fluid is turbulent and the Nuschelt number is

$$N_u = 0.0197(m+2.6)^{0.2}\,\mathrm{Re}^{0.8}\mathrm{Pr}^{0.6}. \quad (11)$$

In Equations (10) and (11), m is the gear module and Pr is the Prandtl number.

The convective heat transfer coefficient α_1 of the meshing surface will change with the position of the meshing point of the tooth surface, the rotational speed, and the working environment, so it is relatively difficult to calculate the exact value, which can be estimated by the following formula [22]:

$$\alpha_1 = \sqrt{\frac{n}{120}} \cdot \sqrt{\lambda\rho_f c} \cdot \left(\frac{\nu_f H_c}{\gamma r_c}\right)^{1/4} \cdot q_{\mathrm{tot}}, \quad (12)$$

where n is rotational speed, λ is the thermal conduction coefficient, ρ_f is the density of lubricating oil or air, c is the thermal capacity, and q_{tot} is the standardized total cooling quantity; see Reference [22]. The other surface heat transfer coefficient α_2 can be approximated by $1/2 \sim 1/3$ of the surface heat transfer coefficient α_3 according to experience. The convective heat transfer coefficient of the central hole and the positioning surface is very small, which can be approximated to 0.

2. Aeronautical Spiral Bevel Gear Modal Equation with Temperature

According to the temperature distribution model established above and considering that the aerial bevel gear mainly works at high speed, based on the traditional linear modal equation, this paper introduces the effect of velocity field and temperature field on its stiffness and establishes the modal equation of the aerial bevel gear under the action of the temperature field.

2.1. Linear Modal Analysis Theory. According to the elastic mechanic finite element method, the motion differential equation of the spiral bevel gear can be obtained:

$$M\ddot{X} + C\dot{X} + KX = F, \quad (13)$$

where M, C, and K are the mass matrix, damping matrix, and stiffness matrix of the gear, respectively; $\ddot{X}$, $\dot{X}$, and X are vibration acceleration, velocity, and displacement vectors of the gear, respectively; and F is the external excitation force vector.

The modal analysis does not consider the external excitation force, that is, $F = 0$. Since the damping matrix is not easy to be diagonalized and has little influence on the natural frequency, the damping term is ignored for the convenience of numerical calculation. The undamped differential equation of motion is obtained:

$$M\ddot{X} + KX = 0. \quad (14)$$

In order to facilitate decoupling, coordinate transformation is needed to transform it into a modal coordinate system. Set $X = X_i \sin \omega_i t$ be the solution of Equation (14), substitute it into Equation (13), and get

$$\left(K - \omega_i^2 M\right)X_i = 0. \quad (15)$$

Because X_i is a non-0 vector, if formula (15) is guaranteed to have a solution, the eigenvalue equation is

$$\left|K - \omega_i^2 M\right| = 0, \quad (16)$$

where ω_i^2 is the eigenvalue and the natural frequency of order i and the corresponding X_i is the eigenmatrix and also the mode vector.

2.2. Modal Equation for Aeronautic Spiral Bevel Gear. The vibration of spiral bevel gears during rotation will change the direction of centrifugal force and lead to the instability of the gear structure. This phenomenon of stiffness matrix changes due to rotation is called rotational softening. As mentioned in Reference [1], the phenomenon of rotational softening is not obvious at low speed, but it has a great

Table 3: The first 20 order natural frequency values without heat load and without rotational speed.

The order	Natural frequency (Hz)
1	4515.4
2	4578.8
3	4581.6
4	4889.3
5	4894.9
6	5487.3
7	5495.5
8	6377.4
9	6377.5
10	6451.7
11	6462.4
12	7795.7
13	7808.7
14	9479.6
15	9494.5
16	11438
17	11454
18	12520
19	12521
20	13608

Table 4: The first 20 order natural frequency values at each speed without thermal load.

The order	The natural frequency (Hz) $n = 100$ rpm	The natural frequency (Hz) $n = 500$ rpm	The natural frequency (Hz) $n = 1000$ rpm	The natural frequency (Hz) $n = 2500$ rpm	The natural frequency (Hz) $n = 5000$ rpm
1	4515.4	4515.4	4515.4	4515.4	4511.1
2	4578.8	4573.3	4566.3	4545.6	4515.4
3	4581.6	4587.2	4594.1	4615.1	4650.3
4	4889.3	4878.2	4864.3	4823	4755
5	4894.9	4906	4920	4962.1	5033.1
6	5487.3	5471	5450.6	5389.8	5290.1
7	5495.5	5512	5532.6	5594.9	5700.4
8	6377.4	6377.3	6377.3	6325	6195.7
9	6377.5	6377.5	6377.6	6377.2	6376.9
10	6451.7	6430.4	6403.9	6377.7	6378
11	6462.4	6483.8	6510.6	6591.8	6729.4
12	7795.7	7770	7737.8	7642.3	7485.8
13	7808.7	7834.6	7867.1	7965.4	8131.9
14	9479.6	9449.8	9412.8	9302.5	9121.5
15	9494.5	9524.4	9561.9	9675.3	9867.2
16	11438	11405	11363	11240	11038
17	11454	11488	11529	11656	11869
18	12520	12520	12520	12520	12520
19	12521	12521	12521	12521	12521
20	13599	13563	13518	13384	13164

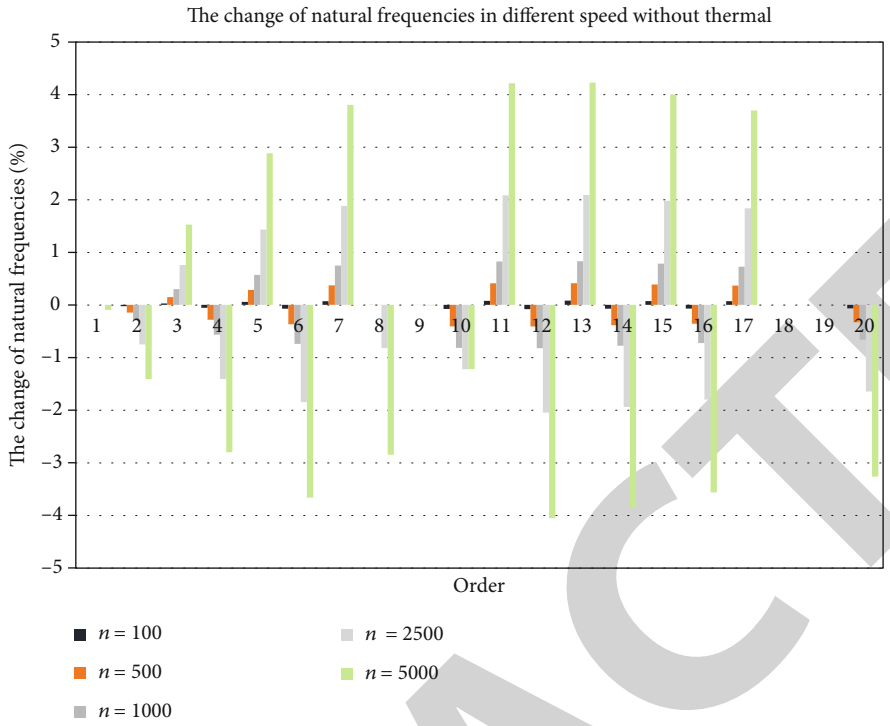


Figure 3: The change of natural frequency at each rotational speed without thermal load.

Table 5: The first 20 order natural frequency values with thermal load and no rotational speed (heat flow = 1000 W).

The order	Natural frequency (Hz)
1	4585.6
2	4586.2
3	4892.8
4	4893.1
5	5485.5
6	5485.6
7	6377.6
8	6377.8
9	6444
10	6444.5
11	7783.4
12	7783.8
13	9463.6
14	9464.8
15	11420
16	11420
17	12523
18	12523
19	13580
20	13581

influence on stiffness at high speed. In modal analysis of aerial bevel gears, the stiffness matrix should include the condition of rotation softening. On the basis of the original stiffness, considering the influence of centrifugal force [23], set

$$K' = K + \Omega^2 M, \tag{17}$$

variables

$$\Omega^2 = \begin{bmatrix} -\left(\bar{\omega}_y^2 + \bar{\omega}_z^2\right) & \bar{\omega}_x\bar{\omega}_y & \bar{\omega}_x\bar{\omega}_z \\ \bar{\omega}_x\bar{\omega}_y & -\left(\bar{\omega}_x^2 + \bar{\omega}_z^2\right) & \bar{\omega}_y\bar{\omega}_z \\ \bar{\omega}_x\bar{\omega}_z & \bar{\omega}_y\bar{\omega}_z & -\left(\bar{\omega}_x^2 + \bar{\omega}_y^2\right) \end{bmatrix}, \tag{18}$$

where $\bar{\omega}_x\bar{\omega}_y\bar{\omega}_z$ is the angular velocity vector $\bar{\omega}$ along the x, y, and z axes.

Substituting K in Equation (16) for Equation (17), the modal equation considering the action of the velocity field is

$$\left|\left(K + \Omega^2 M\right) - \omega_i^2 M\right| = 0. \tag{19}$$

When the temperature field is considered, there will be thermal deformation in the gear tooth surface caused by temperature change. According to thermoelasticity, thermal deformation will produce the corresponding thermal stress field. The existence of the thermal stress field changes the stress state of gear and then produces stress

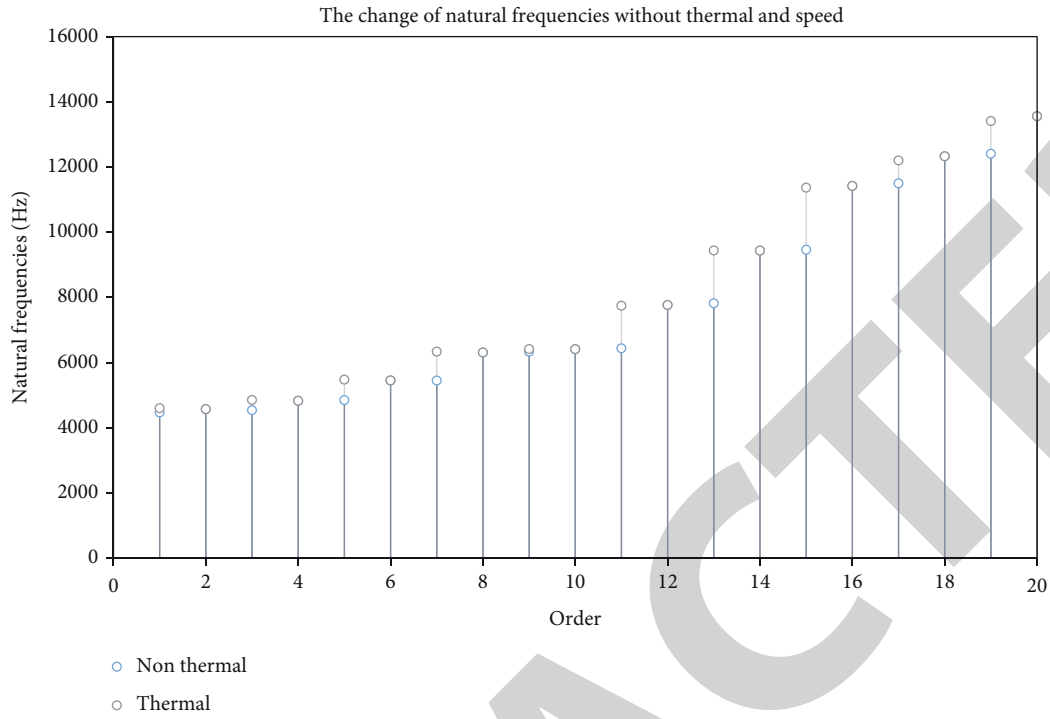


Figure 4: The first 20 order changes of natural frequency value with thermal load and without rotational speed (heat flow = 1000 W).

stiffness (or softening) effect. According to the stress-stiffness relationship in Reference [23], the thermal stress stiffness matrix of the element is assumed to be

$$k_s^e = \int G^T \sigma G d\Omega, \tag{20}$$

where G is the derivative matrix of shape stiffness and σ is the Cauchy stress matrix generated by unit heat.

The thermal stress stiffness matrix k_s^e of each element is combined to obtain the overall thermal stress stiffness matrix K_s. Add the overall thermal stress stiffness matrix K_s to the right end of Equation (17), and obtain the modal equation of aerial bevel gear considering the action of the temperature field:

$$\left|\left(K + K_s + \Omega^2 M\right) - \omega_i^2 M\right| = 0. \tag{21}$$

The temperature field not only produces stress stiffness but also influences the properties of materials, which is not considered in this paper. Therefore, the material property is set to a constant value in the analysis.

3. Modal Analysis of Aeronautic Spiral Bevel Gear at a Steady Temperature Field

3.1. Build Finite Element Model. According to Reference [8], the parameters of an aeronautic spiral bevel gear are tooth number $z_1 = 12 z_2 = 36$, normal module $m_n = 4.9407$ mm, tooth width $b = 22.5$ mm, spiral angle $\beta_m = 35°$, pitch $R_m = 81.1$ mm, normal pressure angle, $\alpha_n = 22.5°$, axis angle, $\Sigma = 90°$.

Firstly, according to the gear parameters, a 3D model of spiral bevel gear is created in UG, as shown in Figure 1. Then, it was imported into the finite element analysis software, and the material characteristics were added for modal analysis. In this paper, the influence of temperature on material properties is not considered, and the material property coefficients such as elastic modulus, density, and Poisson's ratio are all fixed. The gear material used is 16Cr3NiWMoVbE, with elastic modulus $E = 2.10 \times 10^5$ MPa, Poisson's ratio $\upsilon = 0.3$, and density 7.85×10^3 kg/m^3. According to Reference [8], the boundary conditions of steady-state thermal analysis were set. The heat flow was 1000 W, the working temperature was 70°C, and the convective heat transfer coefficient parameters at each part of the gear tooth are shown in Table 1. In general, the calculation accuracy increases with the decrease of mesh density, but the corresponding calculation cost also increases greatly. Therefore, before the modal analysis, the influences of different mesh densities on the calculation results under the same heat flow rate were firstly analyzed in the thermal analysis, and the results are shown in Table 2. As can be seen from Table 2, the influence of mesh density on thermal analysis results can be ignored basically. However, in consideration of the need to transform into thermal stiffness in the next step, the mesh density is selected as 4, and the unit type is SOLID187 to divide the mesh, and the mesh number is 39570. Due to the large number of elements, the overall stiffness matrix state is large, so it is not convenient to give in this paper; this paper only analyzes the finite element results.

Table 6: The first 20 order natural frequency values at each speed with thermal load (heat flow = 1000 W).

The order	The natural frequency (Hz) $n = 100$ rpm	The natural frequency (Hz) $n = 200$ rpm	The natural frequency (Hz) $n = 1000$ rpm	The natural frequency (Hz) $n = 2500$ rpm	The natural frequency (Hz) $n = 5000$ rpm
1	4522.9	4522.9	4522.9	4522.9	4516.8
2	4584.5	4578.9	4572	4551.2	4522.9
3	4587.3	4592.8	4599.8	4620.8	4655.9
4	4890.1	4879	4865.2	4823.9	4755.9
5	4895.7	4906.9	4920.8	4962.9	5034
6	5481.4	5465.1	5444.7	5383.9	5284.2
7	5489.6	5506.1	5526.7	5589	5694.5
8	6377.6	6377.6	6377.6	6312.2	6182.9
9	6377.8	6377.8	6377.8	6377.4	6377.2
10	6438.9	6417.6	6391.1	6378	6378.3
11	6449.6	6471	6497.8	6579	6716.6
12	7777.1	7751.4	7719.3	7623.7	7467.2
13	7790.1	7816	7848.5	7946.8	8113.4
14	9456.7	9427	9389.9	9279.6	9098.7
15	9471.7	9501.5	9539	9652.4	9844.4
16	11412	11379	11337	11214	11012
17	11429	11462	11504	11630	11843
18	12523	12523	12523	12523	12522
19	12523	12523	12523	12524	12524
20	13572	13536	13491	13357	13137

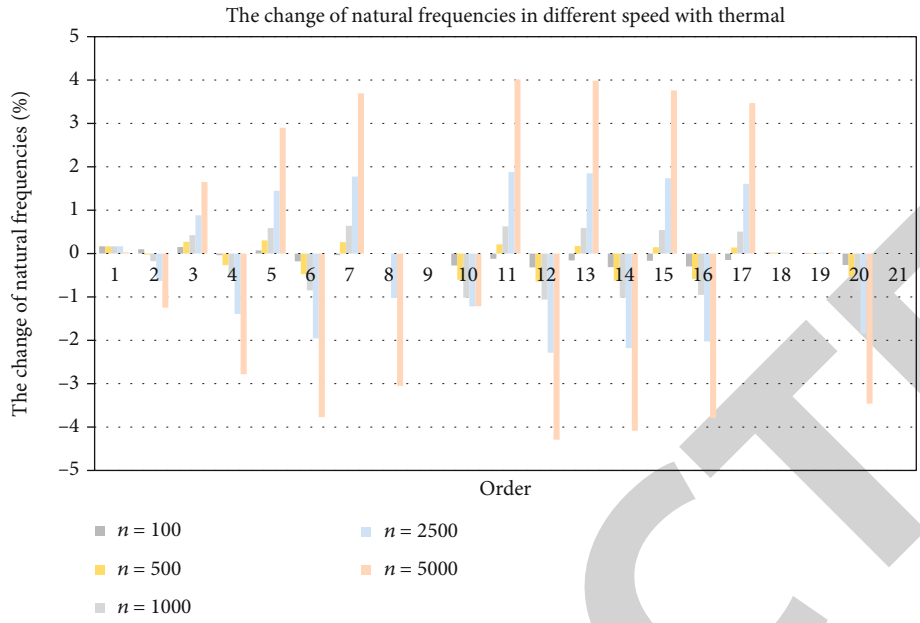


Figure 5: The change of natural frequency value under various rotational speed conditions with thermal load (heat flow = 1000 W).

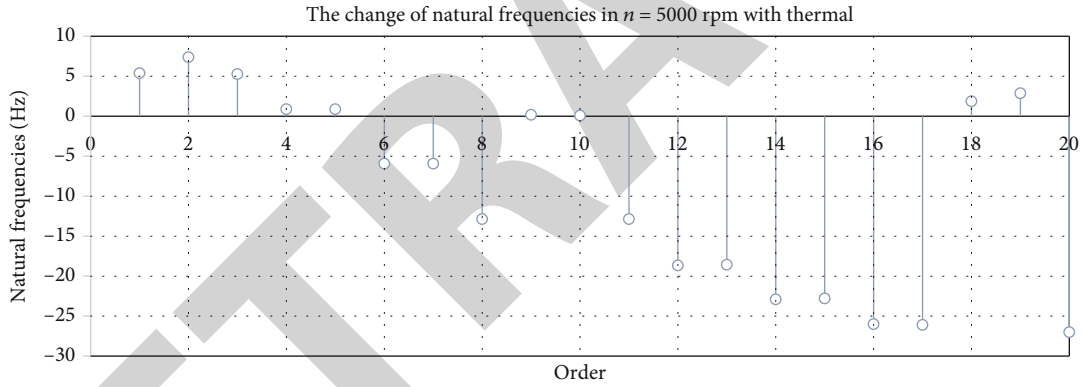


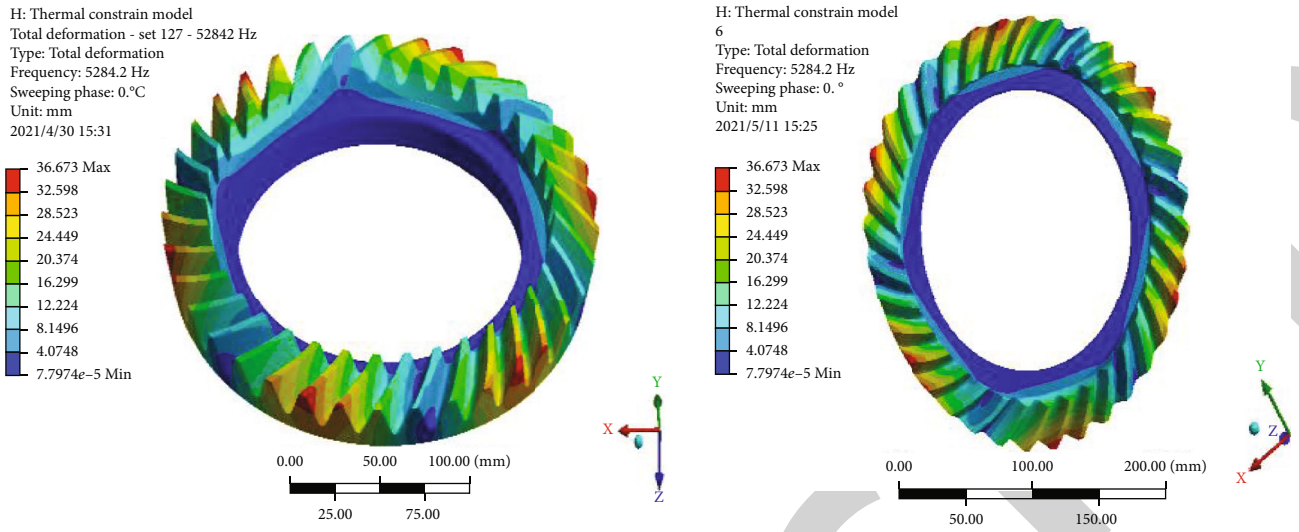
Figure 6: $n = 5000$ rpm change of natural frequency with and without thermal load (heat flow = 1000 W).

3.2. Finite Element Analysis and Results. The output of thermal analysis is thermal deformation, which needs to be transformed into thermal stress through the structural module. And because the nonlinear coupling degree between temperature and structure is not high, the sequential coupling method is used for thermosolid analysis in this paper. The modal analysis of aviation bevel gear under the steady-state temperature field is as follows: Firstly, the temperature field and thermal deformation are calculated by the steady-state thermal module. Then, the thermal stress is calculated according to the deformation of the steady-state structural module. Finally, the calculated thermal stress is introduced into the modal analysis.

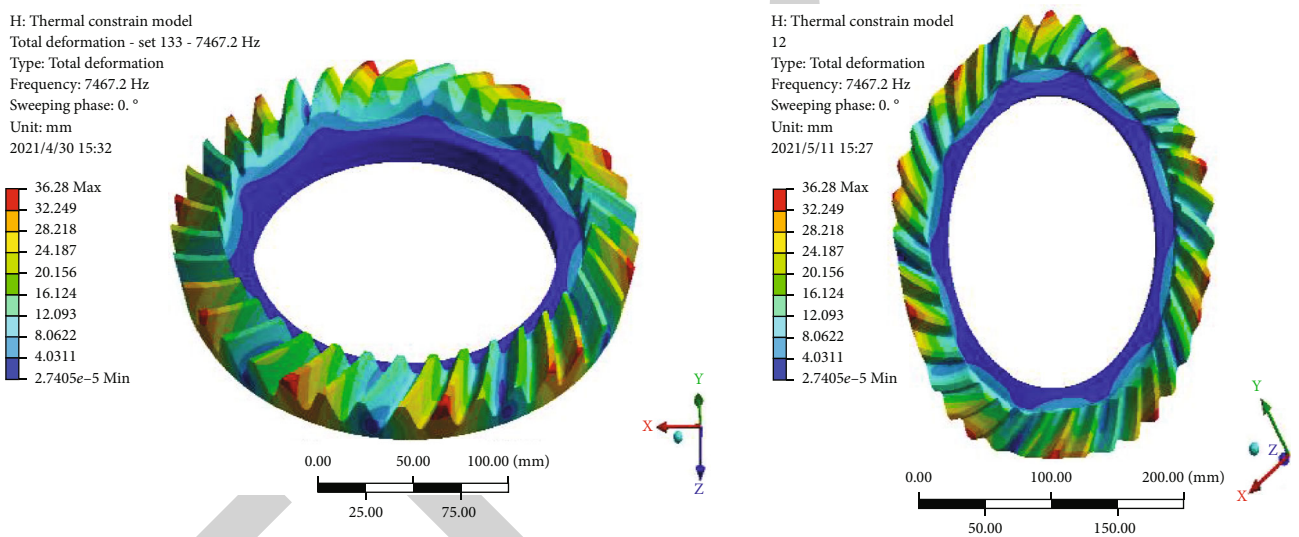
Figure 2 shows the temperature field distribution calculated by the steady-state thermal analysis module. As the heat transfer speed is relatively slow, the solution time is set as 60 s to ensure that the calculated value is more consistent with the real working condition. Except for the three teeth engaged in meshing, the temperature of the remaining teeth is equivalent to the working temperature, and the highest temperature is at the top of the teeth engaged, because the relative slip velocity of the tooth tip is relatively large, which is consistent with the theoretical analysis. Therefore, it can be considered that the temperature distribution is reasonable.

In order to analyze the effects of temperature distribution and rotational speed on the mode of aerial bevel gears, it is necessary to calculate the constrained mode of aerial bevel gears without heat load and rotational speed. For reasons of space, only the first 20 modes are listed. Specific values are shown in Table 3.

Firstly, the influence of rotational speed on aviation bevel gear is considered separately. The speed constraint was added to the modal model without heat load and without speed. The speed conditions were 100, 500, 1000, 2500, and 5000 rpm, respectively, corresponding to the three working conditions of low speed, medium speed, and high speed, respectively. The specific values of the first 20 orders



(a) The 6th mode



(b) The 12th mode

Figure 7: The modes of 7th and 13th order under heat load conditions.

are shown in Table 4. By comparing the data in Tables 1 and 4, the trend of modal changes is shown in Figure 3. On the whole, the modal change can be ignored at low speed. At high speed, especially at $n = 5000$, the modal changes greatly. Among them, the change range of the 12th and 13th order is the largest, and the maximum change value can reach 4.22%. Besides, except for the 1st, 9th, 18th, and 19th order, the modal change of each order is above 1%. It can be seen that the stiffness change generated at high speed is not negligible. Therefore, the effect of high speed on the natural characteristics of bevel gears must be considered when designing them. In addition, it can also be seen from Figure 3 that the symbol of modal difference is changing; that is, the effect of high speed on different orders is different. When the angle between vibration direction and centrifugal force direction of a certain order of vibration mode is less than 90°, stiffness strengthening is displayed; otherwise, stiffness softening is displayed.

Secondly, the influence of the temperature field on modal is considered separately. According to the theory of thermoelasticity, the thermal deformation caused by temperature is calculated first; then, the thermal stress is calculated according to the thermal strain through the constitutive equation of the material, and finally, the calculated stress field is loaded onto the constrained mode without speed. The first 20 order natural frequency values are shown in Table 5. Compared with the natural frequency value under the condition of no heat load and no speed, the change of natural frequency value under the condition of no heat load and no speed was obtained, as shown in Figure 4. As can be seen from Figure 4, modal changes in the first 20 orders are mostly positive changes, among which the 11th order has the largest change range, but overall, the change rate is less than 0.0035%. Therefore, in the case of no rotational speed, the influence of the temperature field on the natural characteristics of aviation bevel gears can be ignored.

Finally, the air bevel gear modal under the action of the temperature field and velocity field is considered. The speed constraint condition was added to the previous model with hot load and no speed, and the speed conditions were 100, 500, 1000, 2500, and 5000 rpm, respectively, corresponding to the three conditions of low speed, medium speed, and high speed, respectively. The natural frequency values of the first 20 orders are calculated numerically, and the specific values are shown in Table 6. Compared with the natural frequency without thermal load and without rotational speed, the modal change trend considering temperature field and rotational speed was obtained, as shown in Figure 5. It can be seen that, similar to the change trend of only rotational speed without considering thermal load, the modal changes greatly at high rotational speed, but the value of modal change changes. Due to space problems, this paper only plots the change of the modal change value of $n = 5000$ (see Figure 6). As shown in Figure 6, the change of multimodal is negative, so it can be seen that the thermal stress generated by the temperature field is opposite to the stress generated by centrifugal force in most cases. To sum up, the rotational speed has a great influence on the variation trend of natural frequency value, while the temperature field has an impact on its value. Therefore, it is necessary to consider the influence of temperature and speed when designing aviation bevel gears.

Modal analysis not only considers the change of natural frequency but also cannot be ignored; that is, temperature and speed have a greater impact on which type of modal. For lack of space, only the case of 5000 r/min is discussed here. It can be seen from Figure 3 that the influence of rotational speed on natural frequency is greater than 4% in orders 11, 12, and 13 and between 3% and 4% in orders 6, 7, 14, 15, 16, 17, and 20. From the temperature field shown in Figure 4, it can be seen that orders 7, 11, and 13 have a great influence on the natural frequency. As shown in Figure 5, when the temperature field and rotational speed coexist, orders 11, 12, 13, and 14 have a greater impact, while orders 6, 7, 15, 16, 17, and 20 take second place. Therefore, the 6th and 12th orders under the action of thermal load were selected to represent low-order and high-order conditions, respectively, for analysis, and the results are shown in Figure 7. The two modes shown in Figure 7 are pitch mode modes. If the node-diameter vibration is involved, the corresponding shape of the vibration mode in the time domain is the beat shape, which is the bending deformation perpendicular to the disk surface, and the change of this type will affect the gear structure, making it prone to failure, fracture, and other failures. Therefore, from the perspective of vibration mode, it is necessary to consider the influence of temperature and speed on the air bevel gear.

4. Conclusion

Based on the linear modal theory, a modal analysis model based on temperature field action is established. According to the numerical analysis of the model for a certain aeronautical bevel gear, the natural frequencies of each order under the action of the temperature field were obtained. Based on the modal analysis, the following conclusions were obtained:

(1) The uneven distribution of the temperature field produces certain thermal stress, and the overall stiffness of gear will change under the action of thermal stress. The complex geometry of bevel gears will increase the inhomogeneity of temperature field distribution. Therefore, temperature has a greater impact on the stiffness of gears than spur gears

(2) Aviation bevel gears will be in high-speed condition, and the centrifugal force generated by high-speed rotation will produce a stiffness hardening effect, but the geometry of bevel gears will change its direction, and when reversed, the softening effect will be reflected

(3) By comparing the results of numerical calculation, it can be seen that the influence of rotational speed on modal is far greater than that of the temperature field on natural frequency when only a single factor is considered in modal analysis, especially in middle and high order modes. The results show that temperature has a certain effect on the natural frequency, and the positive and negative effects are variable

(4) According to the analysis of vibration modes of each step, the temperature field and speed field mainly affect the pitch shape, and the vibration mode has a certain influence on gear failure. Therefore, it is suggested that temperature and speed should be taken into account when designing bevel gears

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The authors declare no conflict of interest.

Authors' Contributions

Wentao Yu and Shijun Liu conceived and designed the experiments; Wenbo Xu performed numerical calculation; Wentao Yu and Dongfei Wang performed the result analysis; Wentao Yu, Shijun Liu, Wenbo Xu, and Dongfei Wang wrote the paper. Dongfei Wang and Wentao Yu contributed equally to this work.

Acknowledgments

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Retraction

Retracted: Analysis and Application of Quality Indicators in Hospital Administrative Management Based on a Fuzzy Hierarchical Model

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] H. Wang, "Analysis and Application of Quality Indicators in Hospital Administrative Management Based on a Fuzzy Hierarchical Model," *Journal of Sensors*, vol. 2022, Article ID 4222894, 13 pages, 2022.

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Research Article

Analysis and Application of Quality Indicators in Hospital Administrative Management Based on a Fuzzy Hierarchical Model

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The core competitiveness of a hospital lies not only in the competition of medical environment, medical technology, and service level but also in the management concept and management level. The decision-making ability, management ability, organization and coordination ability, and innovative thinking consciousness of hospital administrative cadres, both subjectively and objectively, determine the future development and performance of the hospital to a certain extent. Based on the fuzzy hierarchical model, this article analyzes the quality indicators of hospital administration management and finds that in the first-level indicators, work performance and work ability are more important than other indicators; in work performance, goal achievement, work efficiency, and work quality are relatively important. It is necessary not only to ensure the achievement of goals but also to ensure the quality and efficiency of the work; in the work ability, the execution ability and management ability have the largest weight value, so in the process of administrative management, we should focus on cultivating the execution ability and management ability; in the work attitude, the overall concept and leading by example have the greatest weight, so it is necessary to focus on the overall situation and lead by example; in satisfaction, employee satisfaction has the greatest weight, so it is necessary to pay attention to employee satisfaction in order to better retain talents. According to the department's management responsibilities, postcharacteristics, and daily assessment, according to the weights determined by the index system in the management line, and through expert points, the index weights are adjusted for departments with different work characteristics and their actual work conditions. Therefore, in the service guarantee department, the weight of work performance is 30%, the weight of work ability is 20%, the weight of work attitude is 25%, and the weight of satisfaction is 25%. In the technical management department, the weight of management ability is adjusted to 30%, the weight of coordination ability is adjusted to 5%, and the weight of innovation ability is adjusted to 5%. In party and government management, the weight of executive power is adjusted to 30% and the weight of analysis and discrimination ability is adjusted to 5%. In the service guarantee, the weight of adaptability is adjusted to 20%, the weight of coordination and communication ability is adjusted to 15%, the weight of analysis and judgment is adjusted to 15%, and the weight of management ability is adjusted to 10%. By establishing a quality index system suitable for hospital administrative management, the current common phenomenon of low work efficiency, large waste of manpower and material resources, and dependence on "waiting, letter, and inquiry" in hospitals can be changed, and the enthusiasm of hospital management cadres can be mobilized to achieve their goals. Give full play to the multiplier effect of hospital management and improvement, and realize the sustainable development and overall competitiveness of the hospital's overall long-term strategic goals. The implementation of the new medical reform strategy has driven the development and commitment of the medical and health service industry. The development of market economy has become a new challenge as a safe, efficient, convenient, and low-cost way of providing health care services to the masses. The core of hospital competition is not only the competition of medical environment, technology, and medical service but also the competition of concept management and management level. Decision-making ability, leadership ability, organization and coordination ability, and the understanding of the new thinking of hospital management structure determine the future development direction and performance level of the hospital to a certain extent.

1. Introduction

Failure Mode and Effects Analysis (FMEA) is one of the well-known quality management techniques used to continuously improve product or process design. When using this technique, setting a risk priority number (indicating the level of risk associated with a potential problem) is critical to the success of the application. These numbers are often based on past experience and technical assessments, and this approach to risk assessment can sometimes lead to incorrect and conflicting prioritization numbers. When assigning risk priority numbers, an ambiguous logical approach is preferred to eliminate these pitfalls. In this study, fuzzy FMEA was used for the first time to improve the procurement process in a public hospital. The results show that the use of the fuzzy FMEA method can solve the problems encountered by the traditional FMEA, effectively discover the potential failure modes and effects, and also ensure the stability of the process [1]. Hospital performance is a key factor for the success of hospital management, but hospital performance is always uncertain and ambiguous, so formulating scientific evaluation methods has become the main obstacle to effective hospital management. The article presents a complete evaluation method. This method is based on AHP, uses fuzzy cluster analysis to sort the index system, then uses fuzzy analysis to give the scores of all indicators, and finally combines the scores of all these methods to get general results [2]. The Administrative Service Center (ASC) is a newly established public service organization in China. Zhejiang ASC conducted a survey in 2005 and collected a total of 915 samples. The article proposes the use of Hierarchical Linear Modeling (HLM) to study factors affecting services. First, the evaluation is given; second, the conceptual model and assumptions are given; third, the research process is described, including variable design, data selection and collection, reliability and validity, and model estimation. The conclusion is that CSA has direct and indirect effects on the service industry, but the relatively dominant driver of the service industry is the traditional sector. Therefore, some related suggestions are put forward to confirm the status quo of CHW and improve customer satisfaction [3]. This paper briefly introduces the historical development of total quality management and its basic working principles and methods in enterprises and introduces the successful experience of implementing TQM in the United States, Germany, Japan, and Taiwan; also, the specific steps and precautions for implementing TQM in hospitals were discussed. The purpose is to help national hospitals to implement total quality management [4]. The evaluation of travel website service quality (TWSQ) is a multicriteria decision-making problem (MCDM) with strategic implications for travel-related businesses. In real life, decision makers (DMs) encounter a wide variety of TWSQs that are often ambiguous with human subjective judgments. Traditional TWSQ notation methods are insufficient to deal with language notation errors or ambiguities. To overcome this difficulty, the purpose of this study is to propose a hierarchical MCDM evaluation model based on the fuzzy analytic hierarchy process (FAHP) and Ideal Solution Similarity Order Preference Fuzzy Technique (FTOPSIS). The weights of the criteria and the ranking of the alternatives are evaluated by linguistic (natural) variables represented by obscure triangular numbers. Finally, four representative travel websites are provided in Taiwan to illustrate the usefulness of this model. Furthermore, the findings will help station managers to understand their ranking position among competitors, thereby incentivizing station managers to provide an appropriate level of service quality in response to online customers' needs [5]. The objective is to explore the role of nursing grade management in clinical nursing service. The Nurse Hierarchical Management Act has been implemented in six departments. Nurses are divided into five levels: auxiliary nurse (NO), head nurse (N1), nurse (N2), head nurse (N3), and specialist nurse (N4). Identify responsibilities at each level. Straighten out the allocation of nursing staff, implement graded training, and implement a flat responsibility contract system. The nursing quality indicators and patient satisfaction of 6 months before and after the introduction of nursing graded management were compared. The average scores of basic nursing, nursing safety, ward management, and health education were higher than those before graded nursing management ($p < 0.01$). The mean patient satisfaction score after graded nurse management was higher than that before graded nurse management ($p < 0.01$). Nurse management is helpful to improve clinical nursing quality and patient satisfaction [6]. Supplier management plays an important role in the cost and quality performance of a purchasing company. This important role has fostered the development of applied research on multicriteria analytical methods by manufacturing companies, albeit to a lesser extent in the service sector (mainly the health sector). To this end, this study is aimed at demonstrating the effect of applying an ambiguous analytic hierarchy process to a multicriteria analytic procedure in a university hospital to improve the operations and internal controls of pharmacy providers. The main findings and contributions of the study include a detailed description of each step of the method, followed by an industry context showing the application of ambiguous reasoning when analyzing the industry's primary qualitative variables. The findings of this study may provide valuable insights into the dimensions of decision-making reflected in managers' selection of the best-performing teaching hospitals. By understanding these criteria, hospitals can improve service quality by selecting the best deals for medical devices and hospital equipment, thereby providing better services to patients [7]. One of the global concerns of the global health sector is to provide quality hospital services. The management and delivery of healthcare services in hospitals takes place in a highly competitive environment in Turkey. Therefore, in order to be able to make better decisions, services provided by public and private hospitals must be monitored and evaluated according to the ideas of health actors. The article proposes a causal model for evaluating hospital service quality standards. Since the decision-making process involves ambiguity in human judgment, a combination of fuzzy sentences and DEMATEL (Decision Experiment Evaluation Laboratory) methods is employed. The results of the study showed that the level of hospital medical equipment,

nurses and medical staff's attitude towards patients, pharmacist's advice on drug storage, medical staff's professional competence, outpatient waiting time, and number and quality of toilets were checked. This has a greater impact on the quality of service across the hospital. In conclusion, the proposed method will contribute to better delivery of quality health services [8]. A financial analysis system is an important part of hospital financial management. The financial analysis system is a scientific office method for the hospital management to evaluate, analyze, and predict the current hospital financial and management results in order to achieve the expected financial goals. The newly established accounting firm in the hospital requires financial personnel to analyze the differences between the old and new systems. Financial personnel are required to use normative analysis methods to regularly issue financial analysis reports to help hospital managers understand the past, evaluate the present, predict the future, and guide administrative decision-making [9]. First, analyze the four aspects of performance evaluation of the hospital logistics department, then combine the balanced scorecard method and expert consultation method to determine the importance of different levels of indicators, and use the unclear global evaluation process to determine the unclear membership level calculation. The model established in the hospital has obtained the analysis results that are very consistent with the actual evaluation results [10]. Prioritizing outsourced services is a key issue in effective healthcare outsourcing. Despite successful efforts to improve outsourcing processes, it is still possible and necessary to develop a more systematic approach. This paper proposes a novel multicriteria decision model based on the fuzzy analytic hierarchy process (FAHP) for identifying and prioritizing factors affecting outsourcing in hospital settings. A literature review identified 23 factors influencing outsourcing service selection. Among these factors, the 17 most relevant factors were selected based on expert judgment and grouped into four high-level domains: strategy and management, structural and cross-organizational factors, organizational factors, and environmental and service characteristics. Hierarchical models of identified factors were developed and used to design double comparison matrices. The collected data were analyzed and scored using the fuzzy analytic hierarchy process to determine the relative weight and importance of each factor [11]. The purpose of the paper is to study the application of the Delphi method in the design of the evaluation index system of hospital pharmacy management and to establish a scientific evaluation index system method of hospital pharmacy quality management. Comments were summarized using the Delphi method. In the end, a relatively unanimous opinion was obtained, which was used as a reference for obtaining expert opinions by email. During the two consultations, the drug management evaluation index system was divided into two levels of indicators: the first level included three indicators: drug quality assurance system, rational drug use evaluation, and drug service provision system; the second level consisted of three indicators, and it consists of several indicators below the first level. The Delphi method is a systematic, comprehensive, reliable, and objective method, which can be used to design the evaluation index system of hospital pharmacy management [12]. The goal is to come up with a plan to increase customer satisfaction by improving the quality of the hospital's operational services. To this end, an empirical study is carried out, and the hospital administrative services are divided into administrative staff services, medical staff services, agency services, and institutional services. According to the research results, the following suggestions are put forward to improve the quality of hospital management services: on the one hand, the personnel department has made a detailed description of the medical expenditure items, and the waiting time of patients has been reduced through fast case processing and smooth cooperation between departments. Second, in the service of medical staff, it is necessary to simplify the medical treatment process, strictly abide by the consultation time, start outpatient services early, and complete the discharge process. The third involves developing utility spaces and rest areas, expanding the car park, and improving equipment and services for customer menus. Fourth, for institutional services, detailed healthcare charging standards should be published and service efficiency planned [13]. Corporate responsibility has many facets. Companies must organize their business activities in such a way that they have the least impact on the environment, are financially viable, have good working conditions, comply with laws and regulations, etc. Corporate responsibility is closely related to the sustainable development of enterprises, and its impact reflects the economic, ecological, and social status of enterprises. Responsible companies adhere to the principles of data transparency in performance and policy and work to develop strategies to improve sustainability. A model has been proposed that uses loose hierarchical reasoning to assess the sustainability of a company given certain inputs, called benchmarking. Efforts are normalized by their sustainability status and then combined to achieve a sustainability index (0.1) for all aspects of the business. Sensitivity analysis identified the most important indicators of sustainability [14]. The objective is to explore the application of multilevel management in hospital nursing and provide better service for patients. The nursing staff were assessed according to the deployment, and the grading management, hospital nursing quality, nursing job satisfaction, nursing side effects, etc. were compared and analyzed before and after to ensure the continuous improvement of nursing quality. According to the quality of care, patient satisfaction with graded treatment (2013) was significantly higher than that with graded treatment (2012), and the difference was more significant ($p < 0.01$); after graded treatment, the incidence of disease and side effects was significantly lower than that before treatment; the difference was more significant ($p < 0.01$). Line management is an effective nursing management method, which can promote the sustainable development of nursing quality and has clinical applicability [15].

2. Hospital Administration

2.1. Overview of Hospital Administration Work. In the hospital work experience, it is necessary to have a clear

understanding of the concept of administrative work in order to effectively promote the progress of administrative management. Judging from the current research, administrative management can be divided into broad and narrow senses. In the broad sense, administrative management refers to two aspects: administrative management and case-handling management. The narrow management department is mainly responsible for administrative affairs. Office affairs include the design and implementation of relevant systems and procedures, daily management of office affairs, management of office affairs, document management, file management, management meetings, and international management, as well as business travel, real estate, accommodation, vehicles, safety, and hygiene. In the specific work with administrative management, it is mainly through various rules and regulations and human resources to establish a close working relationship between departments or subordinate companies, so that the entire company or unit becomes a single company. Administrative management also has positive value, which can mobilize the enthusiasm of unit employees and help control costs. From the perspective of hospital management, it is administrative management in a narrow sense, specifically referring to the specific work carried out and implemented by the administrative department.

2.2. Current Situation and Problems of Hospital Administration. With the development and expansion of the hospital and the gradual improvement of the level of refined management, the requirements for hospital administrators continue to increase. In order to strengthen the administrative management team, many clinics, nurses, and medical staff are also transferred to the administrative department, because these mobile personnel lack management knowledge and experience, and it is difficult to adapt to the development of administrative functions under the new situation. Medical technicians are regarded as a group that directly creates value for the hospital, so the administrative work of the hospital is not valued. Faced with complex and trivial work on a daily basis, administrative staff often have to invest a lot of time and energy, communicate and coordinate with other departments, and help clinical departments solve problems. The work pressure is high, but the treatment level is low. At the same time, the incentive mechanism for administrative staff is not perfect, there is no scientific and affordable job evaluation method, and the salaries are similar, which seriously affects the enthusiasm of administrative staff, reduces work efficiency, and affects the development of high-quality hospitals. The hospital management system is the basis for the normal operation of the hospital, and the design of the hospital system lacks a systematic long-term control mechanism and dynamic control. The administrative staff did not revise and update the system in a timely manner according to the new requirements of the current medical and health reform and the development status of the hospital. At the same time, many management systems are designed within the administration without discussions and consultations among multiple relevant departments, resulting in a lack of systematization

Figure 1: Current situation and problems of hospital administration.

and coordination in hospital management systems. At the beginning of the establishment of the hospital, there were many administrative departments, and the responsibilities of each department were too general at that time. In order to improve management efficiency and adapt to the new demands of health service development, the hospital continuously adjusts the functions of management departments during the development process, not only creating new functional departments but also merging or refining the original functional departments. Responsibilities between departments are blurred, and individual functions overlap. Due to the complexity of administrative matters, many tasks require coordination and cooperation between multiple departments, and there will be a phenomenon of shirking responsibility between departments, which seriously affects the progress of the work, as shown in Figure 1.

(1) The overall quality of administrative staff is uneven. (2) The treatment level of administrative staff is not high. (3) The administrative management system needs to be improved. (4) Responsibilities between administrative departments are duplicated.

2.3. The Important Connotation of Perfect Administrative Management. Since the reform and opening up, China's comprehensive national strength has improved, the people's living standards and quality have been continuously improved, and the demand for a better life has become more urgent, and China has also had new priorities. In the medical field, people have begun to pay attention to quality medical services. In addition to mutual understanding between doctors and patients, administrative intervention is also an effective tool. Management services should understand the needs of patients and, in some way, directly or indirectly protect the health of patients, meet the spiritual needs of patients, make patients feel humanistic care, and then improve the psychological imbalance of patients. Improving management is of great significance to promoting the development of doctor-patient relationship, establishing correct values, and establishing a good image of the hospital in the

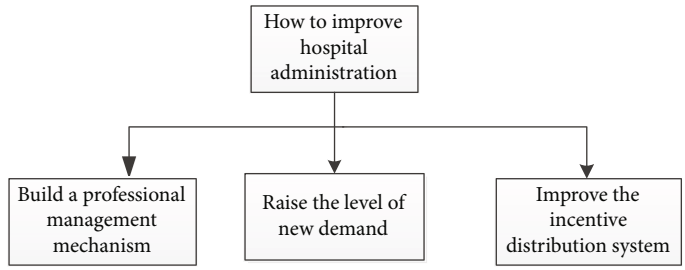

Figure 2: How to improve hospital administrative management.

hearts of patients. Most hospitals have been transformed according to economic development due to the increasing demand for medical care, advances in science and technology, and the way people discover or treat various diseases. With the increase in the number of patients, the hospital's sales level has also shown a continuous upward trend: introducing doctors with high medical knowledge and excellent skills to strengthen the hospital brand. Hospitals continue to expand in size and patient complexity. There are also great difficulties in today's hospital management. In order to maintain the stable and healthy development of the hospital, it is necessary to strengthen the internal management level, improve the operational efficiency, and drive the improvement of the whole enterprise. Many hospitals have begun to use the National Policy Management Law as their hospital guidance to strengthen the structure of internal management departments, and it has been effectively used in practice. By improving the design level of the hospital management team, some hospitals have formulated relevant accountability and comprehensive evaluation mechanisms, deepened hospital work, understood the needs of the masses, increased management accountability, and improved the overall medical service level.

(1) The administrative department needs to understand the needs of patients, directly or indirectly provide protection for the health of patients through some means, meet the spiritual needs of patients, enable patients to feel humanistic care, and then improve the unbalanced psychology of patients

(2) Through effective management, promote the normal turnover of internal work, improve operational efficiency, and drive the improvement of the overall business level

(3) By improving the construction level of the hospital administrative management team, some hospitals have formulated relevant responsibility attribution and comprehensive evaluation mechanisms, in-depth hospital work, understanding of public needs, enhancing the responsibility awareness of managers, and improving the overall evaluation level of medical services

2.4. How to Improve Hospital Administration. The most important factor to improve the service level is to improve the professional level of the administrative staff, which can maintain the stable development of the hospital and improve the comprehensive strength of the hospital to a certain level. The management mechanism for setting up administrative services can target two types of managers, newcomers and veterans. Although the administrative department has recruited outstanding talents selected through multiple levels, it still needs continuous exploration to find the correct management method in the battle itself. The hospital management evaluation mechanism is combined with the basic knowledge of the hospital's daily administrative management and the tone of the work, let the new management understand the hospital's development level and management needs, clarify the work development goals, and have a positive attitude towards administrative management. Ensure the normal operation of the internal work of the hospital, and lay the foundation for the long-term work of the subsequent support factory. The overall development of the hospital requires the joint actions of employees in different positions. The management center should be distributed fairly and should not be overly constrained by traditional development concepts, establish a cross-disciplinary incentive mechanism, allow managers to give feedback on positive salary levels and promotion conditions, and motivate managers to improve job satisfaction and consciously improve job performance. The positive results obtain feedback from the reward mechanism and improve the assessment system, so that active managers have the opportunity to be promoted, and those with strong inertia are eliminated to join, which drives the continuous improvement of the quality of hospital services, establishes a good brand concept, and contributes to the sustainable development of the hospital. Lay the foundation for development, as shown in Figure 2.

(1) Establish a professional management mechanism

(2) Improve the level of new demand

(3) Improve the incentive distribution system

3. Fuzzy Hierarchical Model

3.1. AHP. AHP decomposes complex objective problems into different unit factors, and each unit factor is divided into several groups according to different attributes, thus forming several levels. The top factor is the goal, the middle level is the standard, and the bottom level is the plan, forming a descending hierarchy of dominance, as shown in Figure 3.

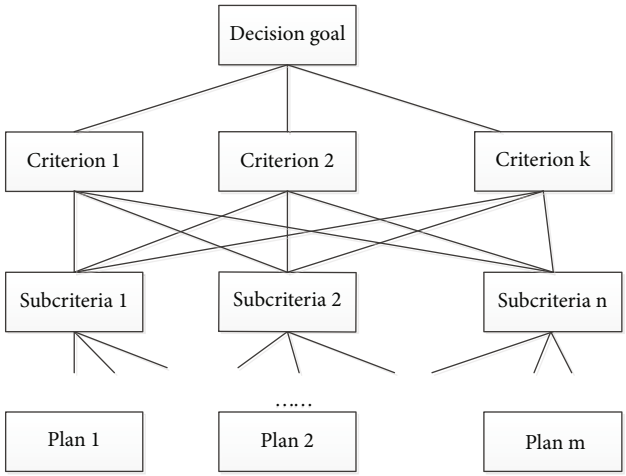

Figure 3: Hierarchical structure.

AHP integrates the principle of pairwise comparison. By comparing two factors in pairs, determine the relative importance of the two factors, and create an evaluation matrix based on this. A final decision is then made as to whether the allocation is appropriate.

W represents the weighting factor of n decision options:

$$W^T = [w_1, w_2, \cdots, w_n]. \tag{1}$$

Pairwise comparison of n decision forms is performed to obtain a score matrix:

$$A = (a_{ij}), \tag{2}$$

where

$$a_{ij} = \frac{w_i}{w_j}. \tag{3}$$

So get

$$AW = nW. \tag{4}$$

If A is a uniformly signed matrix, then n is an eigenvalue of A and W is an eigenvector of A.

$$\lambda_{\max} = n. \tag{5}$$

Shapes are then measured through single-level sorting and hierarchical multilevel sorting, and the preferred solution is determined based on the measurement results.

3.2. Mathematical Model of Fuzzy AHP. The combination of obscure mathematics and the AHP process creates the fuzzy AHP (FAHP) process. The complexity of the objective world and the constant change of perpetual motion machines mean that the world presents random uncertainty and a more general uncertainty and ambiguity. With the development of science, more and more contradictions are encountered, and one of the most prominent contradictions is the contrast between ambiguity and precision. However, in some cases, a certain amount of blur may appear more precise, while overprecision may appear blurry.

In the ambiguous AHP, the ambiguous evaluation matrix is obtained by comparing two factors with each other:

$$A = (a_{ij})_{m\times n}. \tag{6}$$

If it has the following properties:

$$a_{ij} = 0.5, \quad i = 1, 2, \cdots, n, \tag{7}$$

$$a_{ij} + a_{ji} = 1, \quad i = 1, 2, \cdots, n, \tag{8}$$

then, such a matrix is called a fuzzy complementary judgment matrix.

When $a_{ij} = 0.5$ is equal, it means that factor X_i is equally important as factor X_j; when $a_{ij} > 0.5$, it means that factor X_i is more important than factor X_j; when $a_{ij} < 0.5$, it means that factor X_j is more important than factor X_i.

When $a_{ij} = 0.5$, the factor X_i is equally important as the factor X_j; when $a_{ij} > 0.5$, the factor X_i is more important than the X_j factor; when $a_{ij} < 0.5$, the factor X_j is more important than the X_i factor.

Comparing each factor $a_1, a_2, \cdots, a_n$ with each other, the fuzzy complementary judgment matrix can be obtained as follows:

$$A = \begin{pmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{pmatrix}. \tag{9}$$

The weight formula of the fuzzy complementary judgment matrix is

$$W_i = \frac{\sum_{i=1}^{n} a_{ij} + (n/2) - 1}{n(n-1)} \quad (i = 1, 2, \cdots, n). \tag{10}$$

The formula contains the correct properties and scoring information for an ambiguous consensus scoring matrix. The calculation amount is small, and the application is simpler. This is a general formula for solving the dark complementary score matrix weighting formula.

Whether the weight value obtained by formula (10) is appropriate is evaluated by the consistency test. If the offset consistency is too large, the weight values will be unreliable.

A method for checking consistency is by the compatibility of the fuzzy judgment matrix. Assuming that matrices $A = (a_{ij})_{m\times n}$ and $B = (b_{ij})_{m\times n}$ are both fuzzy judgment matrices, we say

$$I(A, B) = \frac{1}{n^2} \sum_{i=1}^{n} \sum_{j=1}^{n} \left| a_{ji} + b_{ij-1} \right|. \tag{11}$$

I is the compatibility index of A and B.

Let the weight vector of fuzzy judgment matrix A be

$$W = (W_1, W_2, \cdots, W_n)^T, \tag{12}$$

in

$$\sum_{i=1}^{n} W_i = 1, w_i \geq 0 \quad (i = 1, 2, \cdots, n). \tag{13}$$

Let $W_{ij} = W_i/(W_i + W_j)(\forall i, j = 1, 2, 3, \cdots, n)$, which is then called the n-order matrix:

$$W^* = \left(W_{ij}\right)_{m\times n}. \tag{14}$$

W is the attribute matrix of the score matrix A.

If the compatibility index $I(A, W)$ is less than or equal to the @ set by the decision-maker, it means that the consistency meets the requirements; the smaller the @ is, the higher the decision-maker's consistency requirements are, usually @ = 0.1.

When the compatibility index $I(A, W)$ is less than or equal to the decision-maker's attitude @, it means that the consistency is in line with the requirements; the smaller the @ is, the higher the decision-maker's requirements for consistency, generally desirable @ = 0.1.

3.3. Establishment of the Improved Fuzzy Analytic Hierarchy Process. Although AHP based on an ambiguous scoring matrix overcomes some shortcomings of traditional AHP, it is difficult to ensure the consistency of the ambiguous scoring matrix, and the final calculation results are not satisfactory. It is an ideal decision-making method to introduce the concept of the ambiguous consistent matrix and choose a more reasonable plan accordingly.

Let matrix $R = (r_{ij})_{m\times n}$, if the conditions are met:

$$0 \leq r_{ij} \leq 1 \quad (i = 1, 2, \cdots, n; j = 1, 2, \cdots n). \tag{15}$$

Then, R is said to be a fuzzy matrix.

If the fuzzy matrix $R = (r_{ij})_{m\times n}$, the conditions are met:

$$r_{ij} + r_{ji} = 1 \quad (i = 1, 2, \cdots, n; j = 1, 2, \cdots n) \tag{16}$$

Then, the fuzzy matrix R is called a fuzzy complementary matrix. The nature of $R = (r_{ij})_{m\times n}$ reflects the consistency of people's thinking and judgment. When factor I is more important than factor J and factor J is more important than factor K, factor I must be more important than factor K. When factor I is less important than factor J and factor J is less important than factor K, factor I must be less important than factor K.

Among them, $r_{ij} = 0.5$, which means that factor i and factor j are equally important; $0 \leq r_{ij} \leq 0.5$ means that factor j is more important than factor i, and the smaller r_{ij} is, the more important constraint j is than factor i; $0.5 \leq r_{ij} \leq 1$ means that factor i is more important than factor j, and the larger r_{ij} is, the more important the factor i is than the factor j.

The method of adjusting the fuzzy complementary matrix to a fuzzy consistent matrix is as follows: sum the fuzzy complementary matrix $R = (r_{ij})_{m\times n}$ row by row, denoted as $r_i = \sum_{k=1}^{n} r_{ik}$, $i = 1, 2, \cdots, n$, and perform the following mathematical transformations:

$$r_{ij} = \frac{r_i - r_j}{2n + 0.5}. \tag{17}$$

Calculate the priority value s_i^k of the k factors under scheme A_i, using the square root method:

$$s_i^k = \frac{\bar{s}_i}{\sum_{i=1}^{n} \bar{s}_i}, \tag{18}$$

in

$$\bar{s}_i = \left(\prod_{i=1}^{\pi} r^k u\right)^{1/n}. \tag{19}$$

The total ranking formula of the hierarchy is

$$s_i = \sum_{k=1}^{m} w_k \cdot s_i^k. \tag{20}$$

Sorting $s_i(i = 1, 2, 3, \cdots, n)$ can get the ranking of the superiority of n schemes under the influence of m factors.

(1) Clarify decision-making goals, determine object attributes, and establish an index system

(2) Formulate the contents of the expert consultation letter, select the expert consultation, and summarize the calculation consultation results. The answers obtained will directly affect the calculation results of the fuzzy analytic hierarchy process and the actual effect of the application

(3) According to the fuzzy analytic hierarchy process calculation steps and corresponding formulas, perform hierarchical single ranking, calculate the priority value, obtain the average priority value, calculate the final evaluation value in combination with the weight, and finally perform a total hierarchical ranking

(4) Evaluate each scheme according to the final calculation result, and select the optimal scheme

4. Analysis and Application of the Quality Index Based on the Fuzzy Hierarchical Model in Hospital Administration

4.1. Constructing the Quality Index System in Hospital Administration. To build the quality index system in hospital administration, firstly, the quality indexes in hospital

administration are divided into two parts. The first-level indexes are from four aspects: work performance, work ability, work attitude, and satisfaction; the second-level indexes have a total of 17, which are goal achievement, work efficiency, work quality, cost control, management ability, communication and coordination ability, adaptability, innovation ability, analytical judgment, overall concept, leading by example, diligence, execution, morality, words and deeds, and leadership satisfaction. 17 impact factors were assigned and calculated to form quantitative evaluation indicators, as shown in Table 1.

4.2. Screening of the Index System by the Delphi Expert Consultation Method. A total of 20 experts participated in the screening work. A total of 20 consultation forms were distributed, 20 were recovered, and 20 were valid. The effective recovery rate was 100%. Through statistical analysis of the first-level indicators, the arithmetic mean of work performance is 4.89, which meets the threshold standard; the arithmetic mean of work ability is 4.83, which meets the threshold standard; the arithmetic mean of work attitude is 4.56, which meets the threshold standard; in satisfaction, the arithmetic mean of the degree is 4.17, which meets the cutoff criterion, as shown in Table 2.

It can be seen from Figure 4 that the statistical analysis of the first-level indicators shows that the full score ratio of work performance is 0.89, and the coefficient of variation is 0.27, which both meet the threshold standard; the full score ratio of work ability is 0.83, and the coefficient of variation is 0.33, all of which meet the threshold standard. The full score ratio of work attitude is 0.72, and the coefficient of variation is 0.64, all meeting the threshold standard; the full score ratio of satisfaction is 0.33, and the coefficient of variation is 0.78, all meeting the threshold standard.

After summarizing the expert scores, calculate the arithmetic mean, full score ratio, and coefficient of variation of each indicator. In this way, each indicator has three judgment scales. In order to avoid the exclusion of important indicators, the exclusion criteria of the specially set indicators are as follows: any indicators with more than two judgment scales that do not meet the threshold standard will be excluded. From Table 2 and Figure 4, it can be judged that the first-level indicators do not meet the set index exclusion criteria, so the first-level indicators are retained.

From Table 3, it can be seen that the arithmetic mean of target achievement is 13.44, the full score ratio is 61, and the coefficient of variation is 0.65, which meets the threshold standard; the arithmetic mean of work efficiency is 13.67, the full score ratio is 56, and the coefficient of variation is 0.55, which meets the threshold standard. The arithmetic mean of work quality is 13.67, the full score ratio is 56, and the coefficient of variation is 0.55, which meets the threshold standard; the arithmetic mean of cost control is 13.67, the full score ratio is 56, and the coefficient of variation is 0.55, which meets the threshold standard; the arithmetic mean of management ability is 13.11, the full score ratio is 44, and the coefficient of variation is 0.63, which meets the threshold standard; the arithmetic mean of communication and coordination ability is 13.11, the full score ratio is 50, and the coefficient of variation is 0.66, which meets the threshold standard; the arithmetic mean of strain capacity is 12.33, the full score ratio is 38, and the coefficient of variation is 0.83, which meets the threshold standard; the arithmetic mean of innovation ability is 13.11, the full score ratio is 50, and the coefficient of variation is 0.7, which meets the threshold standard; the arithmetic mean of analytical judgment is 13.22, the full score ratio is 56, and the coefficient of variation is 0.74, which meets the threshold standard; the arithmetic mean of the global concept is 12.67, the full score ratio is 44, and the coefficient of variation is 1.07, which meets the threshold standard. The arithmetic average is 12.22, the full score ratio is 33, and the coefficient of variation is 0.81, which meets the threshold standard; the arithmetic mean of execution is 13.78, the full score ratio is 61, and the coefficient of variation is 0.55, which meets the threshold standard. The ratio is 33, and the coefficient of variation is 0.81, which meets the threshold standard; the arithmetic mean of leadership satisfaction is 12.11, the full

Table 1: Quality index system in hospital administration.

First-level indicator	Secondary indicators
Work performance	Goal achievement
	Work efficiency
	Work quality
	Cost control
Ability to work	Management ability
	Communication and coordination ability
	Resilience
	Creativity
	Executive power
	Analytical judgment
Work attitude	Global concept
	Lead by example
	Diligent
	Moral words and deeds
Satisfaction	Leadership satisfaction
	Employee satisfaction

Table 2: Statistical analysis table of the arithmetic average scoring results of the first-level indicators of expert consultation.

First-level indicator	Arithmetic mean
Work performance	4.89
Ability to work	4.83
Work attitude	4.56
Satisfaction	4.17
Mean	4.61
Standard deviation	0.57
Threshold	4.04

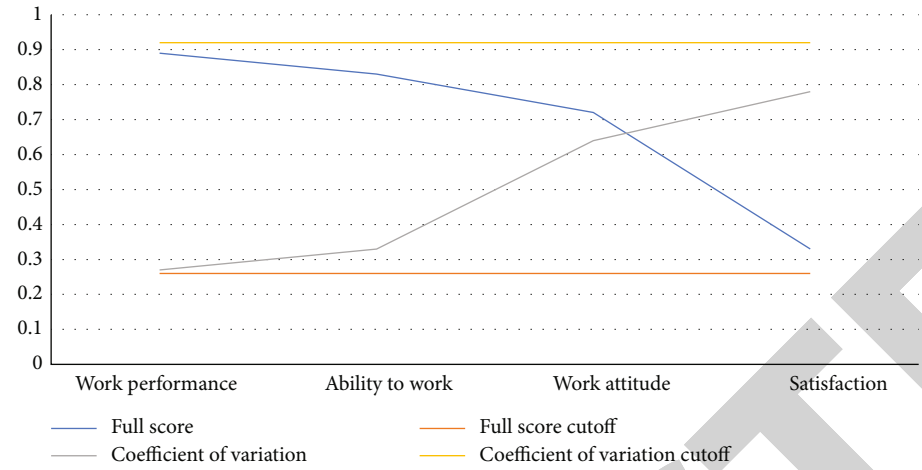

Figure 4: Statistical analysis table of the full score ratio and coefficient of variation scoring results of the first-level indicators of expert consultation.

Table 3: Statistical analysis table of scoring results of secondary indicators of expert consultation.

Secondary indicators	Arithmetic mean	Full score	Coefficient of variation
Goal achievement	13.44	61	0.65
Work efficiency	13.67	56	0.55
Work quality	13.67	56	0.55
Cost control	12.22	22	0.81
Management ability	13.11	44	0.63
Communication and coordination ability	13.11	50	0.66
Resilience	12.33	38	0.83
Creativity	13.11	50	0.7
Executive power	13.78	61	0.55
Analytical judgment	13.22	56	0.74
Global concept	12.67	44	1.07
Lead by example	12.33	50	1.05
Diligent	12.22	39	0.96
Moral words and deeds	12.22	33	0.81
Leadership satisfaction	12.33	22	0.76
Employee satisfaction	13.11	50	0.76
Mean	12.88	46.05	0.77
Standard deviation	0.74	3.61	0.39
Threshold	12.14	41.6	1.16

Table 4: Level indicator weight scoring.

First-level indicator	The average score	Weights
Work performance	4.53	0.35
Ability to work	4.47	0.35
Work attitude	3.07	0.2
Satisfaction	1.67	0.1

score ratio is 22, and the coefficient of variation is 0.76, which meets the threshold standard; the arithmetic mean of employee satisfaction is 13.11, and the full score ratio is 50. The coefficient of variation was 0.76, which met the threshold standard; the secondary indicators also met the conditions.

4.3. Weight Value of the Quality Index System in Hospital Administration. According to the method, the weight of the first-level indicators is calculated, and the importance is sorted. It can be seen from Table 4 that the highest weights in the first-level indicators are work performance and work ability, with a weight of 0.35; the weight of satisfaction is the lowest, with a weight of 0.1; and the weight of work attitude is 0.2.

In work performance, goal achievement, work efficiency, and work quality have the largest weights, with a weight of

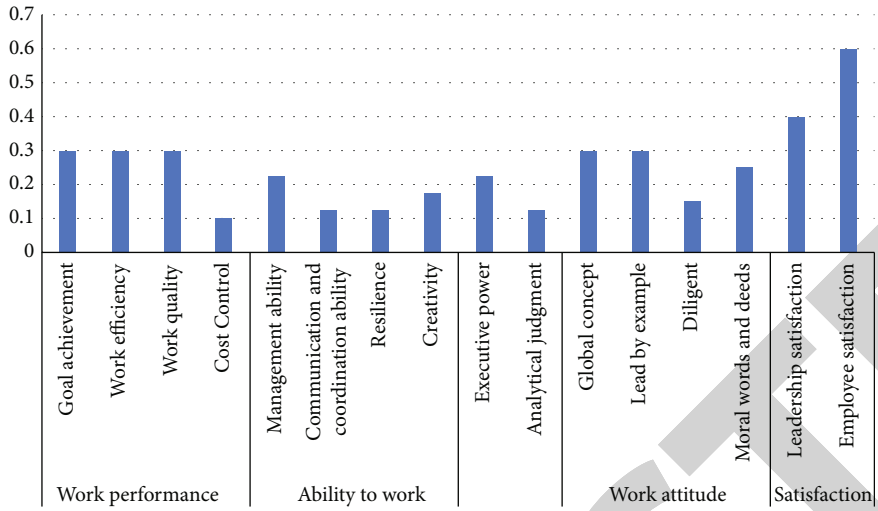

Figure 5: Weights of secondary indicators under each primary indicator.

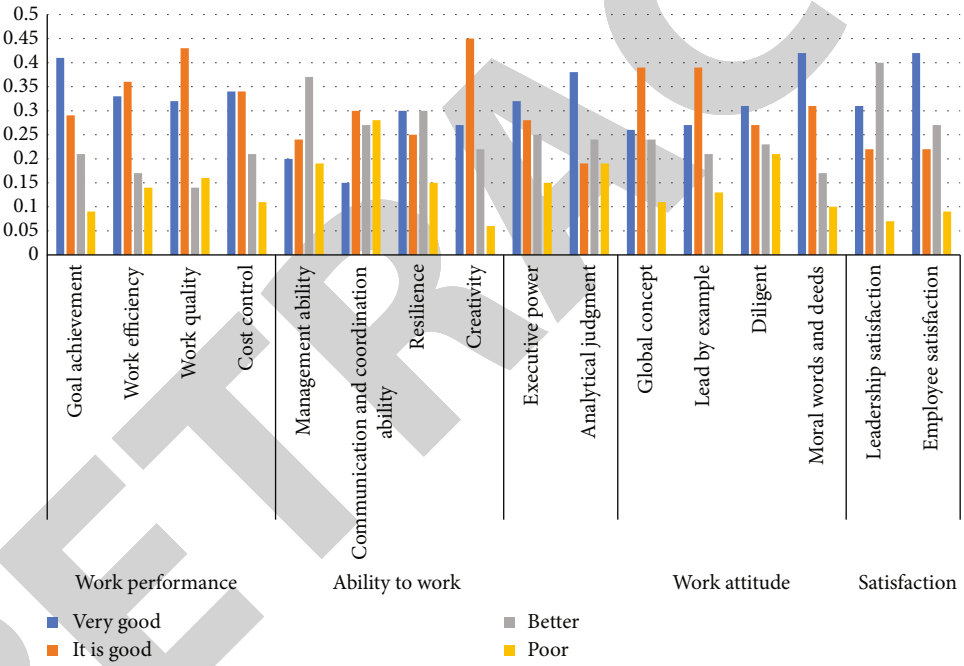

Figure 6: Comment set of secondary indicators.

0.3, and cost control has the smallest weight, with a weight of 0.1; in work ability, execution and management capabilities have large weights, with a weight of 0.225; the weight of coordination and communication ability, adaptability, analysis, and judgment is the smallest, the weight value is 0.125, and the weight value of innovation ability is 0.175; in the work attitude, the overall concept and leading by example have the largest weight value, and the weight value is 0.3, followed by morality, words and deeds, and diligence; in satisfaction, employee satisfaction has the largest weight, with a weight value of 0.6, followed by leadership satisfaction, with a weight of 0.4, as shown in Figure 5.

In the work performance, the "very good" has the highest rating for the achievement of the goal, with a rating of 0.41. In cost control, the evaluation value is 0.21; the work quality has the largest evaluation value of "poor," and the evaluation value is 0.16; in the work ability, the analysis judgment has the evaluation value of "very good," and the evaluation value is 0.38. Innovation ability has the highest value of "good," which is 0.45; management ability has the highest value of "good," and the value of "poor" is 0.37. Communication and coordination ability has the highest value of "poor," which is 0.28; in the work attitude, morality and words and deeds have the highest value of "very good," and the value of "good" is 0.42; overall concept and leading by example have the highest value of "good," the value of "very good" is 0.39, and the value of "good" is 0.39. The overall concept has the largest value, and the evaluation

Table 5: The single order and total order of the secondary index level.

First-level indicator	Secondary indicators	Hierarchical single sorting weights	Hierarchical total ranking weight
Work performance	Goal achievement	0.3	0.064
	Work efficiency	0.3	0.0797
	Work quality	0.3	0.0641
	Cost control	0.1	0.084
Ability to work	Management ability	0.225	0.0836
	Communication and coordination ability	0.125	0.071
	Resilience	0.125	0.0517
	Creativity	0.175	0.065
	Executive power	0.225	0.051
	Analytical judgment	0.125	0.0472
Work attitude	Global concept	0.3	0.0455
	Lead by example	0.3	0.034
	Diligent	0.15	0.0767
	Moral words and deeds	0.25	0.0725
Satisfaction	Leadership satisfaction	0.4	0.054
	Employee satisfaction	0.6	0.056

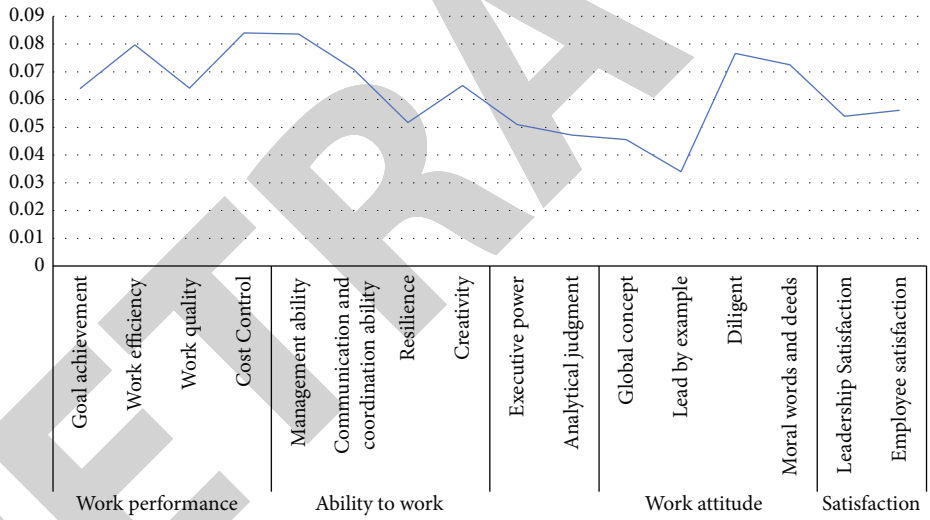

Figure 7: The total ranking weight of the secondary index hierarchy.

value is 0.24; the most diligent have the "poor" evaluation value, and the evaluation value is 0.21; in the satisfaction, the largest employee satisfaction has the "very good" evaluation value, and the evaluation value is 0.21. It is 0.42. The "good" comment value is the largest for leadership satisfaction and employee satisfaction, and the comment value is 0.22; the "good" comment value is the largest for the leadership satisfaction, and the comment value is 0.4; and the "poor" comment the highest value for employee satisfaction, with a comment value of 0.09, as shown in Figure 6.

As can be seen from Table 5 and Figure 7, the overall ranking of management ability in the secondary indicators has the largest weight, with a weight of 0.0837, followed by work efficiency, diligence, cost control, morality, communication and coordination, work quality, innovation ability, goal achievement, employee satisfaction, leadership satisfaction, adaptability, execution, analytical judgment, overall concept, and leading by example.

4.4. Adjustment of Indicator Weights for Department Categories. According to the department's management responsibilities, characteristics, and daily assessment, according to the weights determined by the index system in the management line, and through expert points, the index weights are adjusted for departments with different work characteristics and their actual work conditions. In the service guarantee department, the weight of work performance before adjustment is 35%, the weight after adjustment is 30%, and the weight is reduced by 5%; the weight of work ability before adjustment is 35%, the weight after adjustment

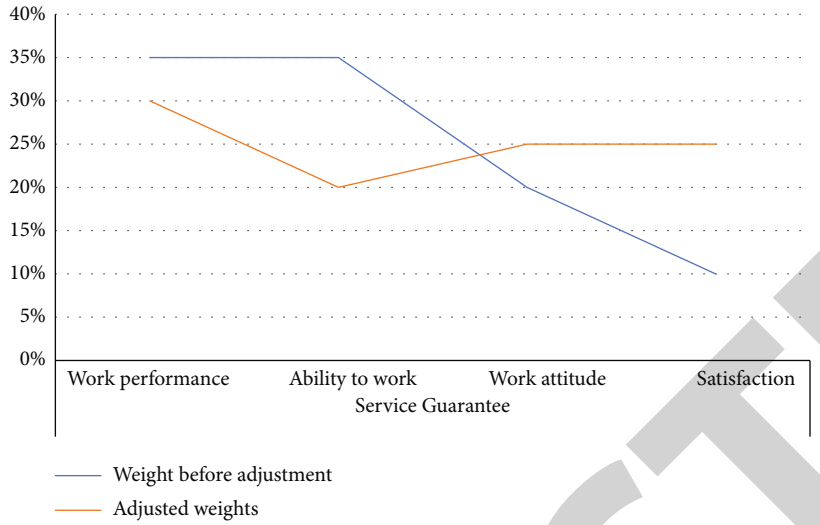

Figure 8: Adjustment of weights of primary indicators.

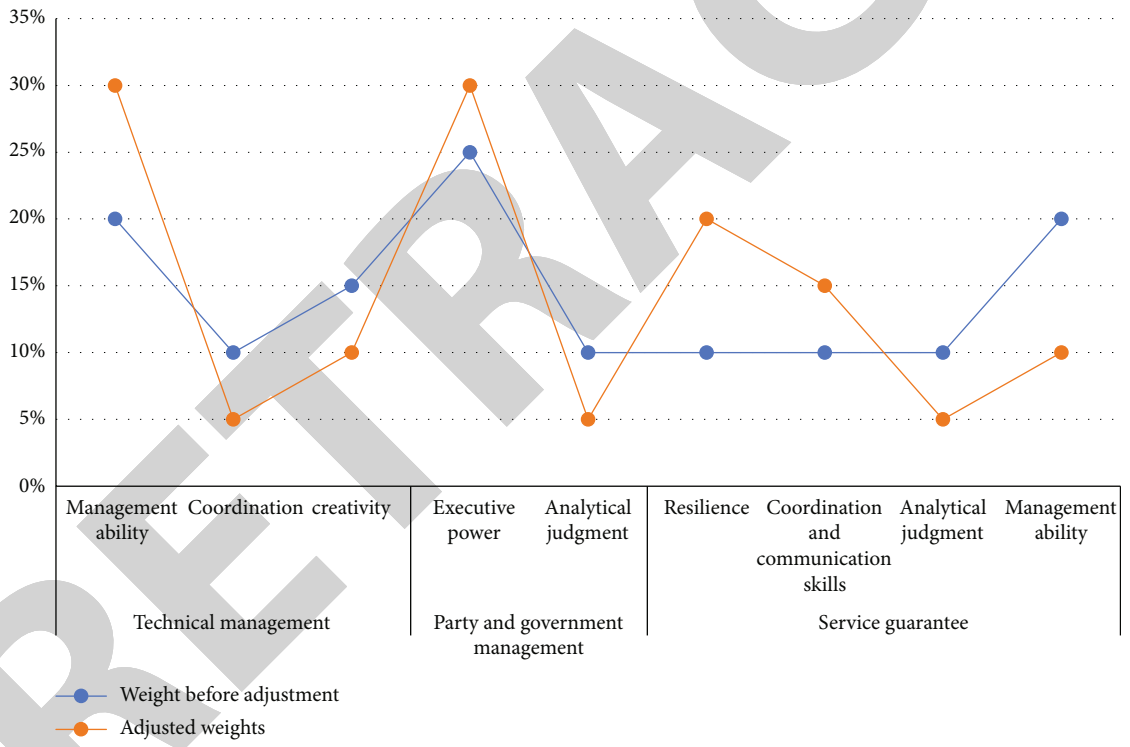

Figure 9: Secondary indicator weight adjustment.

is 20%, and the weight is reduced by 15%; the weight before work attitude adjustment is 20%, and the weight after adjustment is 25%, with an increase of 5%; the weight of satisfaction before adjustment is 10%, and the weight after adjustment is 25%, with an increase of 15%, as shown in Figure 8.

As can be seen from Figure 9, in the technical management department, the weight of management ability has been increased from 20% to 30%, the weight of coordination ability has been reduced from 10% to 5%, and the weight of innovation ability has been reduced from 15% to 5%. In party and government management, the weight of executive power was raised from 25% to 30% and the weight of analysis and discrimination ability was lowered from 10% to 5%. In service guarantee, the weight of adaptability has been increased from 10% to 20%, the weight of coordination and communication ability has been increased from 10% to 15%, the weight of analytical judgment has been increased from 10% to 15%, and the weight of management ability has been reduced from 20% to 10%.

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Retraction

Retracted: Design of New Working Environment Based on Artificial Intelligence Algorithm

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] B. Zhou and L. Qu, "Design of New Working Environment Based on Artificial Intelligence Algorithm," *Journal of Sensors*, vol. 2022, Article ID 6130761, 11 pages, 2022.

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Research Article

Design of New Working Environment Based on Artificial Intelligence Algorithm

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With the three industrial revolutions sweeping the world, especially since the third industrial revolution, the complexity of human work has greatly increased, and in the new era of technology and information, workers have new standards and new requirements for their work environment, and new form of work environment design has come into being. In this paper, a work environment system is designed by artificial intelligence algorithm to improve the workers' work environment by assessing the good and bad degree of their natural and social work environment, and an intelligent service system is designed by using artificial intelligence algorithm, which can not only analyze and process the work environment assessment results but also execute the subjective and reasonable requirements made by the workers to help the workers maintain a good mood at work and improve their efficiency.

1. Introduction

The work environment, i.e., the environment in which the worker lives, can be subdivided into the social environment and the natural environment, which is necessary for the worker to complete the work efficiently and successfully. Natural environment generally refers to the temperature, climate, humidity, vibration, noise, lighting, odor, and other natural factors of the worker's environment. Social environment mainly refers to social work activities such as workers' communication with people, participation in group activities, and group building in the work process [1]. Both the natural and social environments can have a great impact on human work status and work efficiency. If the work environment is not good, the worker's body and mind will cause great harm and will lead to some unsafe events, not only affect the work process; if the work environment is relatively bad, it will cause serious personal injury. Thus, to improve the efficiency and protect the physical and mental health of workers, it is necessary to improve the working environment of workers, to create a comfortable natural environment and a comfortable social environment, and to design and improve both working environments with the times, in order to protect the health and safety of workers [2].

The continuous development of artificial intelligence and algorithms has made the human living environment gradually intelligent [3]. In today's data era, the increasing development of big data and the continuous upgrading of data algorithms give a solid foundation and fertile ground for algorithms to move from simple algorithms to intelligent algorithms [4]. Artificial intelligence algorithms provide tremendous support and backing for humans to predict results, build models, process data, etc. The most core element in the development of artificial intelligence is the intelligence of algorithms [5]. Intelligent algorithms act on all aspects of human life through big data, and as the amount of data increases, the algorithms are upgraded, and big data is applied to life day by day, greatly advancing artificial intelligence that meets the application requirements of the times. The main application of artificial intelligence algorithms is to calculate the correlation of big data and apply the data to the practical needs of humans and daily life, developing the understanding of big data in the process. However, for humans, AI algorithms have become increasingly involved

and are slowly becoming part of the choice and guidance of the direction of human development. In terms of the nature of big data and AI algorithms, AI algorithms determine the way in which data is analyzed and interpreted [6].

The use of AI algorithms for the design of new forms of work environments is a very useful approach. The use of AI algorithms for the analysis of work environments that affect human work can be used to design new forms of work environments that better meet the needs of human work and increase efficiency by examining the main factors of big data. In an environment where various industries are blossoming and the types and requirements of various jobs are increasing, workers' requirements and standards for their work environments are also showing a gradual increase. The complexity of the natural and social environment has also increased [7]. The behavior of workers is the main reason that affects the efficiency of work and their own physical and mental health, while the work environment is the direct reason that affects the behavior of workers [8]. Therefore, it is of great significance to provide and guarantee a good working environment for workers and to achieve efficient control of their working environment from the root by designing and improving it to improve their safety and health as well as their work efficiency [9].

The significance of this paper is to clearly describe the specific design of the work environment that affects the interaction of workers' behavior and safety, to improve the current research gap, and to improve the understanding and control of the work environment design practitioners on their work and work content. In addition, this paper seeks to combine artificial intelligence algorithms, through continuous experimentation and iteration, to eventually derive the focus of work environment design and distill it into a specific design framework. The specific framework and the focus of work environment design will be used to guide the practice of work environment design, to ensure the effective implementation of work environment design and to further extend the experience gained to guide real-life production practices. The research methodology used in this paper can be applied not only to work environment design but also can be easily transferred to other fields and industries to provide ideas for subsequent research on work environment design in various fields [10].

In this paper, we analyze big data through artificial intelligence algorithms and design a work environment system to improve workers' work environment by assessing how good or bad their natural and social work environments are and design an intelligent service system using artificial intelligence algorithms that can not only analyze and process the work environment assessment results but also execute the subjective and reasonable requests provided by workers to help workers maintain a good mood at work and improve the efficiency of workers [11].

2. Research Background

The development of artificial intelligence has had a profound impact on society, human development, and progress. As an important part of artificial intelligence technology, intelligent algorithms play an important role in the process of information transmission [12]. The research on artificial intelligence can be traced back to the relevant theories of modern neuroscience: there are many neocortex in the human brain, which can be used as the carrier of learning knowledge and producing memory. Cognitive neuroscience grew out of the study of the neocortex in the human brain. This is the study of the human nerves and mind. It focuses on the neurons in the cerebral cortex. With the deepening of the research of this science and gradually applying to the development of algorithms, artificial intelligence algorithms have been constantly developed and improved [13].

In the 1950 s, the Canadian psychologist works published about behavioral science and neuroscience, this book gives a new explanation on learning and memory, the memory mechanism of nerve in this innovative book proposes a "synaptic plasticity of neural mechanisms," and the neural mechanism means the neurons that fire at the same time are connected to each other, also known as Hubb's law [14].

At Dartmouth in 1956, the development of artificial intelligence was given direction and goals. Two years later, an American scholar put forward a kind of very practical-perceptron network model, it is a kind of single neural network model of variable parameters, and the model through the algorithm describes the use of human brain learning process makes the machine through the data knowledge learning; it is the foundation of machine learning and laid the core framework for machine learning. Since then, people's research on theories related to cognitive neuroscience has developed rapidly. Especially after the 1990s, artificial intelligence technology has developed more rapidly and has been closely linked with various disciplines [15].

Since the beginning of the 21st century, Internet technology has been developing rapidly, computer technology has been improving continuously, and the proportion of personal computers has also been rising. The computing power and data integration ability of computers have been enhanced [16]. Researchers have proposed deep learning algorithms based on big data. At present, deep learning has been applied to speech recognition, image analysis, and other fields in a wide range and deep dimension and has achieved very obvious results. Nowadays, artificial intelligence technology is shining in all fields [17]. For example, artificial intelligence and network can maintain the network and provide personalized service needs according to the characteristics of each network user. Another example is artificial intelligence and medicine, which can summarize and process patients' past medical records and reports. After big data analysis, it can put forward auxiliary treatment measures or disease prediction for patients, with high accuracy. In today's era, the national economy is the lifeblood of any country [18]. In the economic and financial field, artificial intelligence will analyze the needs of customers, customize personalized financial plans according to the requirements, predict the trend of stock funds, and avoid risks. It can be said that the development of artificial intelligence is remarkable; now it has been widely used in smart phones, tablets, computers, attendance systems, and other aspects.

There are three main areas of research in artificial intelligence: natural language processing, computer vision, and deep learning [19]. The steps of natural language processing simply have two steps; one is natural language understanding, but natural language generation. Natural language processing for human and machine is introduced, its purpose is to realize the communication between people and machine, it is used by human natural language input, it may be not accurate enough into a computer but can accurately identify and determine the internal language; all in all, natural language processing is to get the natural language to realize unambiguous, universal high quality computer language transformation. Computer vision is to let the machine instead of the biological eyes "see the world," using the camera record, and then computer analysis, so as to track and identify the observed target, so that you can get the needed information from pictures, videos, and other multidimensional perspective [20]. With the continuous development of computer technology in artificial intelligence algorithm, computer vision technology has been able to deal with problems including image recognition and image processing. This technology has been applied to face recognition, fingerprint recognition, and many other fields to identify and authenticate human beings. Artificial intelligence algorithms are a broad umbrella term that can be subdivided into many subcategories, including machine learning, representative learning, and deep learning. Among them, the deep learning algorithm is to use the computer to establish a network for information transmission, similar to the neocortex of neurons in the brain, so that the computer can acquire knowledge and skills and continuously learn and organize, so as to improve its own performance.

For artificial intelligence system, it should have the characteristics of cognitive ability such as learning and reasoning, which requires the system to have the support of hardware and software at the same time, that is, computer, recognizer, various algorithms, and so on. In these modules, algorithm is the most important and is the most critical module to achieve intelligence. Artificial intelligence and algorithms continue to integrate into and adapt to the needs of daily life. With continuous evolution, iteration, and development, human beings can more easily understand and transform the world. At the same time, artificial intelligence also makes the world closely linked together, and artificial intelligence will be more widely used in all aspects of human life in the future.

The discussion and research on artificial intelligence technology is the most interdisciplinary and broadest research at present. The combination of artificial intelligence and traditional industries has also created new opportunities for many traditional industries. With the development of science and technology, the continuous improvement of artificial intelligence, and the continuous application of artificial intelligence to various fields, most countries around the world have made the development of artificial intelligence a key development object, and now various fields have more or less changed under the progress of artificial intelligence, such as the way of work and industrial structure, which has a significant impact on the development of human society. In the future, AI technology will be integrated and reshaped into various industries as a basic need, and the development of AI technology will be faster and faster. As long as all industries can clearly develop their goals, find their future development direction, rationally combine with AI, and reasonably use the convenience brought by the development of technology; then in the future, AI will definitely bring greater convenience and development to human society.

3. Materials and Methods

3.1. The Overall Framework of Artificial Intelligence Algorithm. Intelligent algorithms are generally designed and used based on two basic motives: one is to purposefully provide information that the user is expected to receive; the other is to provide information that the user himself needs. Artificial intelligence is for humans, so human needs must be taken into account, which places higher development requirements on AI to incorporate more algorithms and use more data collection and analysis methods. After collecting data, the AI algorithm can perform data analysis, design subsequent execution steps, and then design subsequent algorithms for different steps; by analyzing the collected data, it is possible to get the ideal environmental needs of workers as much as possible and to evaluate the working environment of workers, so as to provide personalized work demand configuration; managers can, based on the data, use the data to make more reasonable work arrangements for workers.

In order to analyze the strengths and weaknesses of the current worker environment and to provide intelligent services based on worker needs, we first need to build a software work environment, i.e., a system that can monitor and evaluate. In the Python language environment, the data acquisition system, image and speech recognition system, and artificial intelligence algorithms required for the system can be implemented.

The software system mainly consists of three main systems. The system's operating environment design system module is mainly responsible for the collection, setup, and organization of various data, in addition to the supervision and inspection of the work of other system modules. The work environment assessment system is mainly divided into natural environment assessment and social environment assessment. The natural environment assessment system mainly collects the data of temperature, humidity, and noise of the workers' working environment and then evaluates them; the social environment assessment system mainly evaluates the workers' status in the work, work efficiency, and the behaviors generated in the work. The intelligent service system is to provide workers with personalized configurations when they need services, such as whole hour chime, off duty reminder, break prompt, and take-out order. The overall model of the system is shown in Figure 1.

First of all, there is the operation environment design system, which is an important part to ensure the normal operation of the whole assessment system, and it is mainly responsible for the collection, setting, and finishing of

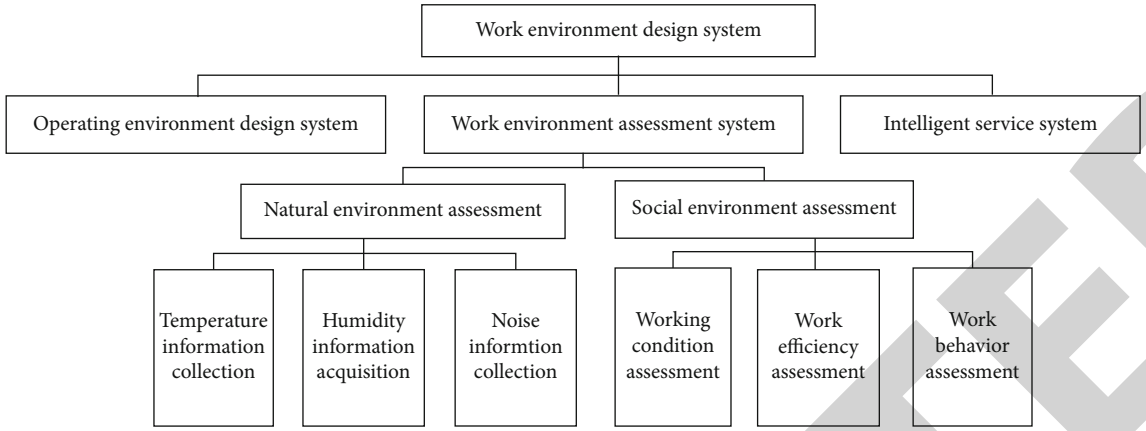

Figure 1: Overall model of work environment assessment system.

various data. This operation environment design system can be simply divided into three aspects: system environment parameters, work environment assessment parameters, and data management settings. System environment parameters include commuting time, worker list, and basic office environment structure. Work environment evaluation parameters include temperature collection system, humidity collection system, noise collection system, workers' work content, and the number of times to use Internet applications collection. The data management setup is to organize and classify all the data needed for the operation of the whole system and to coordinate and regularly optimize all the algorithms involved in the operation of the system.

The most important part of the whole system is the work environment assessment system.

Temperature information is collected through temperature sensors, transmitted to the computer, and analyzed by artificial intelligence algorithms. A good working environment for workers needs to maintain a suitable temperature, and because the temperature is too low or too high, it will have a negative impact. When the working environment temperature is too high, the body will keep sweating, blood output will increase, pulse rate accelerates, and it is easy to feel dry mouth, but it also affects the attention, more likely to affect the human memory and thinking, in the psychological irritability. In the low-temperature environment, the body surface temperature drops, pores and blood vessels contract, people will become pale, pulse and breathing weaken, and blood pressure drops; low-temperature environment will also affect the dexterity of the hands and hand coordination; in addition, the low-temperature environment will lead to weakened nerve conduction, psychological tension, and anxiety.

Humidity information collection needs to be passed through the humidity sensor, transmitted to the computer, and analyzed by artificial intelligence algorithms. The humidity of the working environment is the degree of dryness and humidity of the air in the working environment, which is generally described by relative humidity, which is the ratio of actual water pressure to saturated water pressure. If the humidity in the air is too high and too low, it will have a bad impact, and for too high humidity, the impact on people is a little more. For example, if the worker is in an environment with a low temperature, but the humidity is high, moisture will further absorb heat in the body, people will produce a strong feeling of cold, cold hands and feet, and in the long run, it also triggers arthritis easily; If workers are in an environment with high temperature and high humidity, they will feel sticky on their bodies; this is because sweat cannot be discharged properly, and in the long run, people's throat and breathing will also feel very uncomfortable.

The noise information is collected through the noise monitor, and the results are transmitted to the computer and analyzed by artificial intelligence algorithm. Noise in the work environment has a negative impact on people both physically and psychologically. Noise can cause an accelerated pulse rate and increased blood pressure, disrupting a person's normal metabolism. If the worker is in a work environment that is often disturbed by very strong noise, the person's vision will also have a bad effect, which sounds unbelievable, but in fact, noise can make people's eyesight diminish. Not only that, but noise can also do great harm to the worker's stomach and intestines, which may cause gastroenteritis, stomach ulcers, and other very serious gastrointestinal diseases, causing great harm to the human body. In short, noise has a very negative impact on workers.

These natural environmental factors are synthesized through monitoring and analysis and algorithms and finally will be displayed to the workers, who can make positive adjustments to improve their natural working environment according to the current working environment they are in.

The work status assessment is done by evaluating the worker's work process in terms of arrival time, discipline at work, work motivation, emotional stability at work, work skills and learning progressiveness, and drawing the corresponding conclusions. If the worker's working condition is not good, the system will give corresponding prompts and make corresponding adjustment measures according to the worker's own condition and make some comments; if the worker's working condition meets the work requirements and is in the ideal condition, he can continue to work and the system will continue to evaluate.

Work efficiency assessment, as the name implies, is to analyze the efficiency of the worker's work. During working

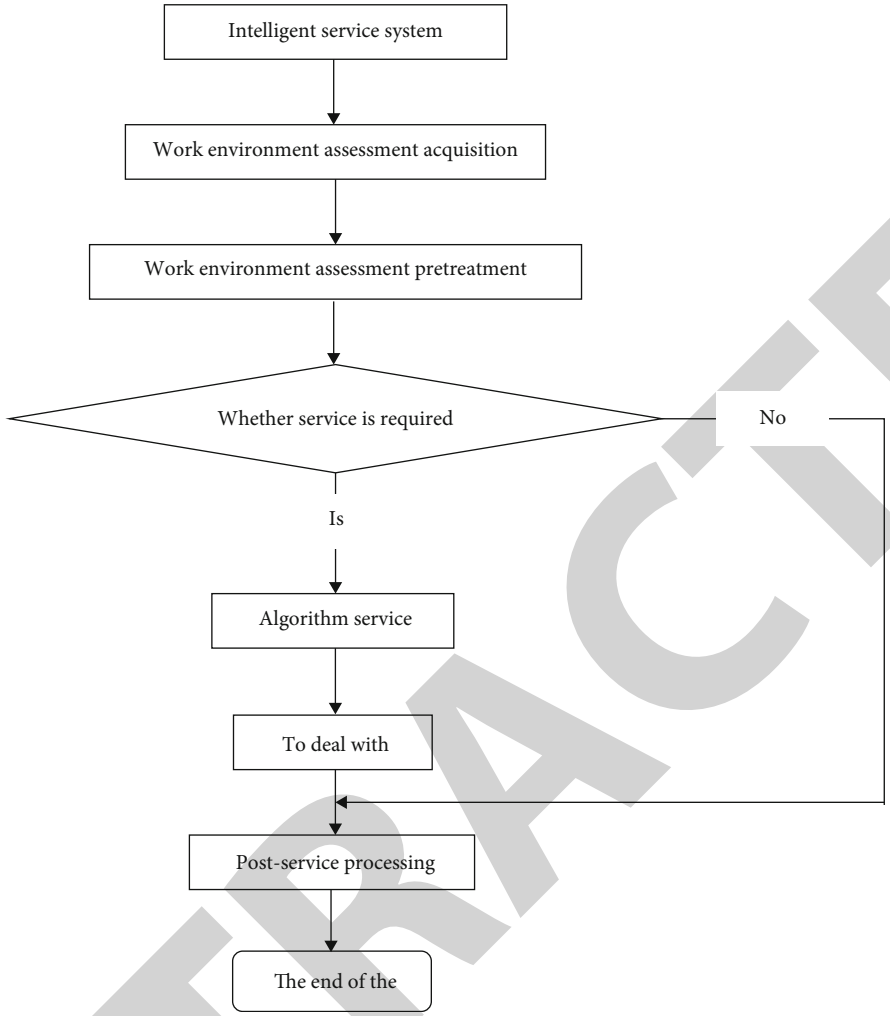

Figure 2: Intelligent service system workflow diagram.

hours, the worker's work efficiency is evaluated by recording the length of various applications of the worker using the Internet, comparing the time needed to complete a certain work with the time actually completed, and measuring the degree of work completion and other aspects. If the worker's normal work efficiency meets the requirements, he or she is given a confirmation; if the worker's work efficiency is too low, or if he or she often does something else during working hours, he or she is given a reminder or warning to try to ensure that the worker makes full use of working hours and completes his or her work on time.

Work behavior refers to various work-related behaviors at work, such as mutual communication among colleagues, attending meetings, completing work independently, inspecting work, and traveling. These are normal behavioral patterns at work. Evaluating these patterns is helpful for workers to summarize and reflect on their work. By evaluating and analyzing work behaviors, the system can also predict the work patterns of the worker so that the worker can be reminded to do the corresponding work at the appropriate time.

Social environment assessment is an effective way to improve the working environment and increase the efficiency of workers.

3.2. Intelligent Service System Working Mode Design. The workflow diagram of the intelligent service system is shown in Figure 2.

Based on this analysis, the specific requirements of the system are as follows.

First, there is the real-time work environment assessment and processing requirement. The system is an intelligent service system based on deep learning algorithm, so it is indispensable to obtain real-time work environment assessment, and at the same time, the active instruction of workers is also the data source for the work of intelligent service system.

Second, it is the integration of deep learning algorithms and inference calculation demand. There are many models and frameworks of deep learning in the current industry, so how to unify these algorithmic models and be able to meet the real-time requirements of real-life scenarios is a crucial issue. At the same time, future iterations of algorithmic models with excellent performance and good functionality will be available, and the system needs to update and extend these algorithms in a timely manner.

In addition to this, there are multiple data, especially feature vectors, storage, and query requirements. The system

gets a large amount of data after the algorithms handle the work environment assessment or the subjective requirements of workers, and only by storing these data can we get accurate results in the subsequent analysis.

Not only that, the distributed deployment and expansion of the system are also important. Standing in the development perspective, the future belongs to big data; for the single machine, the system can carry a limited amount of data, and it is one of the factors that hinder the development of the system, and the distributed deployment of the system can solve this problem; once the system is not able to meet the current data processing needs, we only need to increase the server to meet the demand.

Finally, it is the need for an interface that is easy for workers to operate. The interface of the system is a layer of direct contact for workers, who can exercise subjective control over the intelligent service system through the interface or follow the recommendations provided on the interface based on the results of the work environment assessment.

3.3. Design of Artificial Intelligence Algorithms. The creation of the different work environment assessment models designed in this paper needs to be implemented using a very common classification algorithm in artificial intelligence algorithms, which is called the plain Bayesian classification algorithm. This algorithm focuses on classifying different feature conditions in the collected data by the classical plain Bayesian algorithm so that their joint probability distribution can be calculated. Using the obtained joint probability distributions, it is possible to calculate their posterior probabilities, which for this paper are the different environmental assessment systems. This classification algorithm calculates the posterior probabilities from the distribution probabilities, so it is possible to find very accurate environmental assessment system; the various data collected through different sensors and identifiers should belong to and thus move to the next level of algorithmic evaluation. The main process of the plain Bayesian classification algorithm is as follows:

Assume that the classification model samples are as follows: $(x_1(1), x_2(1), x_3(1), \cdots x_n(1), y_1)$, $(x_1(2), x_2(2), x_3(2), \cdots x_n(2), y_2), \cdots$, $(x_1(m), x_2(m), x_3(m), \cdots x_n(m), ym)$, i.e., there are m samples, each sample has n features, and the feature output has K categories, defined as $C_1, C_2, \cdots, C_k$.

The prior probability distribution and conditional probability are used to obtain the joint distribution as follows.

$$\begin{aligned} P(X, Y) &= P(X, Y = C_k)P(Y = C_k)P(X = x|Y = C_k) \\ &= P(Y = C_k =)P(X_1 = x_1, X_2 = x_2, \cdots, X_n = x_n|Y = C_k), \end{aligned} \tag{1}$$

where equation (1) is calculated, and the plain Bayesian model assumes that the n dimensions of X are independent of each other, so that it can be derived:

$$\begin{aligned} &P(X_1 = x_1, X_2 = x_2, \cdots, X_n = x_n|Y = C_k) \\ &\quad = P(X_1 = x_1|Y = C_k)P(X_2 = x_2|Y = C_k) \\ &\qquad \cdots P(X_n = x_n|Y = C_k). \end{aligned} \tag{2}$$

Calculate all the K conditional probabilities $P(Y = C_k|X = X^{(\text{test})})$, and then, find the category corresponding to the largest conditional probability. The predicted category C_{result} is the category that maximizes the calculation result, and the mathematical expression is as follows:

$$\begin{aligned} C_{\text{result}} &= \underbrace{\text{argmax}}_{C_k} P\left(Y = C_k \middle| X = X^{(\text{test})}\right) \\ &= \underbrace{\text{argmax}}_{C_k} P\left(X = X^{(\text{test})}|Y = C_k\right) \bullet \frac{P(Y = C_k)}{P\left(X = X^{(\text{test})}\right)}. \end{aligned} \tag{3}$$

$P(Y = C_k|X = X^{(\text{test})})$, and the denominator of equation (3) is the same as $P(X = X^{(\text{test})})$; therefore, the prediction formula can be simplified as follows:

$$C_{\text{result}} = \underbrace{\text{argmax}}_{C_k} P\left(X = X^{(\text{test})}|Y = C_k\right)P(Y = C_k). \tag{4}$$

Using the independence assumption of the plain Bayesian, the plain Bayesian inference formula in the usual sense can be obtained:

$$C_{\text{result}} = \underbrace{\text{argmax}}_{C_k} P(Y = C_k)\prod_{j=1}^{n} P\left(X = X_j^{(\text{test})}|Y = C_k\right). \tag{5}$$

Secondly, the evaluation algorithm used in this paper is a multilayer evaluation method for work environment systems based on multiple limit learning machines. In the first layer of the evaluation model, the evaluation results are first given quickly for some operating points (OPs) that are far from the stability boundary of the system. In this layer, only a small number of ELM features to be selected is used because the OPs are easy to discriminate. It is also easy for the computer to process the data, which ensures a certain evaluation speed. For OPs close to the stability boundary, the first layer cannot give a confident evaluation result and will be sent to the second layer. In the second layer, more features and ELMs are added to ensure the evaluation accuracy. The evaluation process is similar to the first layer. Samples that still cannot give a confidence assessment result will be sent to the third layer and so on. If an accurate conclusion still cannot be given in the final layer, it means that the OP is extremely close to the stability boundary of the system, at the edge of stability and instability, and its state is difficult to estimate. The evaluation model performs the first layer of transient stability assessment on the samples in the dataset: first, different ELMs are trained using the core set of features extracted based on the MRMR algorithm, and then, multiple ELMs are used to evaluate the previous samples, and some of the samples will obtain stable or unstable confidence assessment results, while the samples that cannot obtain confidence assessment results will be sent to the

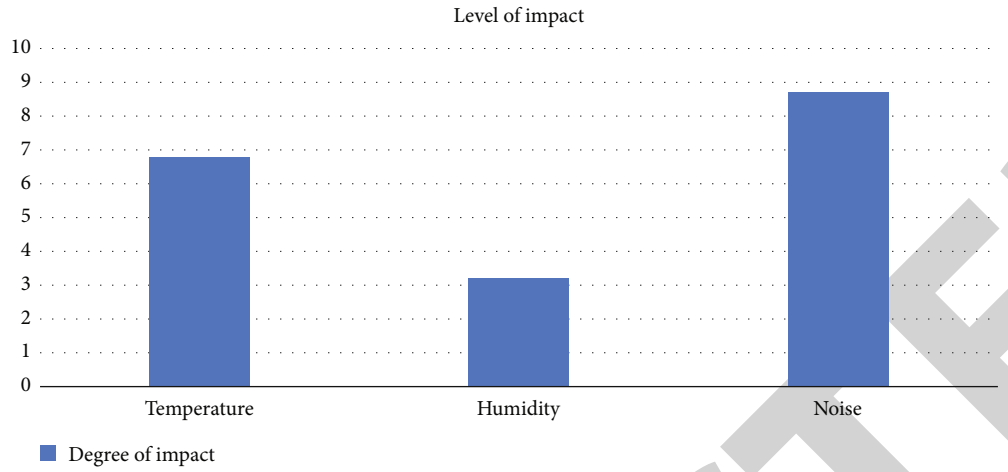

Figure 3: The degree of influence of natural environmental factors on workers' work efficiency and physical and mental health.

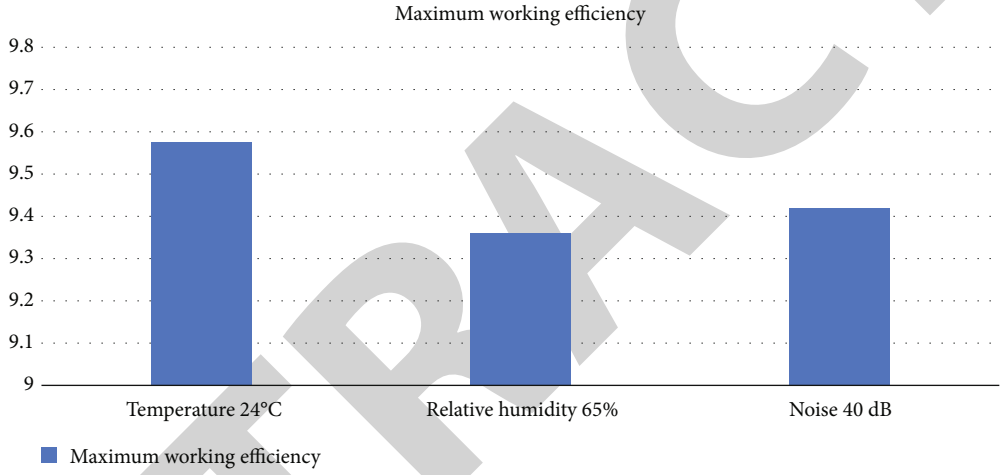

Figure 4: Graph of temperature, humidity, and noise environment results for the highest work efficiency (maximum value of 10).

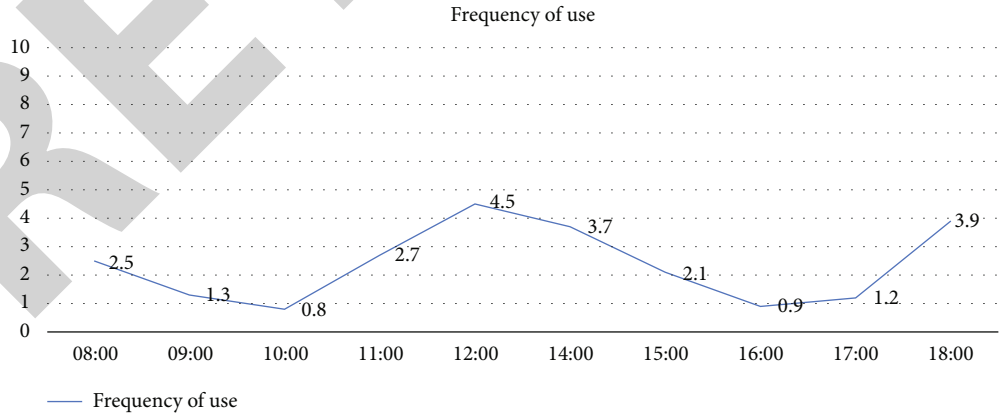

Figure 5: Frequency of using applications other than work in different time periods.

second layer; in the second layer, there are more core features and the number of ELMs; repeat the process in the first layer, and send some samples that cannot obtain confidence assessment results to the next layer, until all samples are evaluated.

4. Results and Discussion

The survey showed that the three aspects of natural environmental factors that affect workers' work environment, namely, temperature, humidity, and noise, have the degree

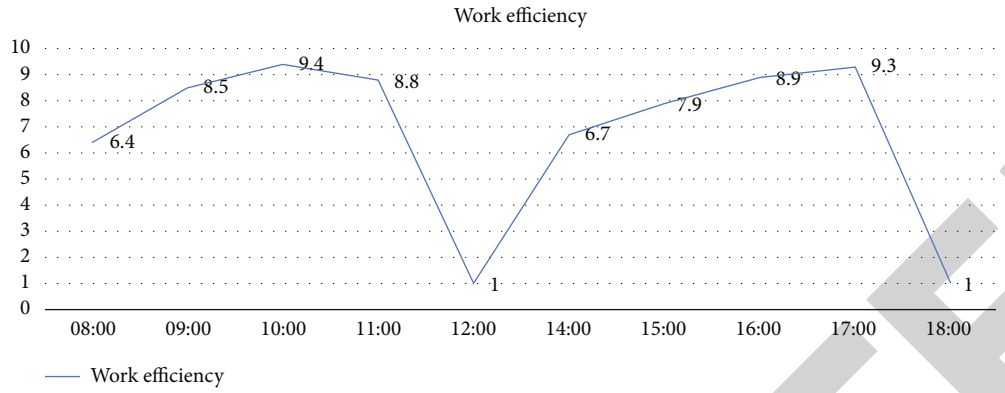

Figure 6: Work efficiency of workers in different time periods during work hours.

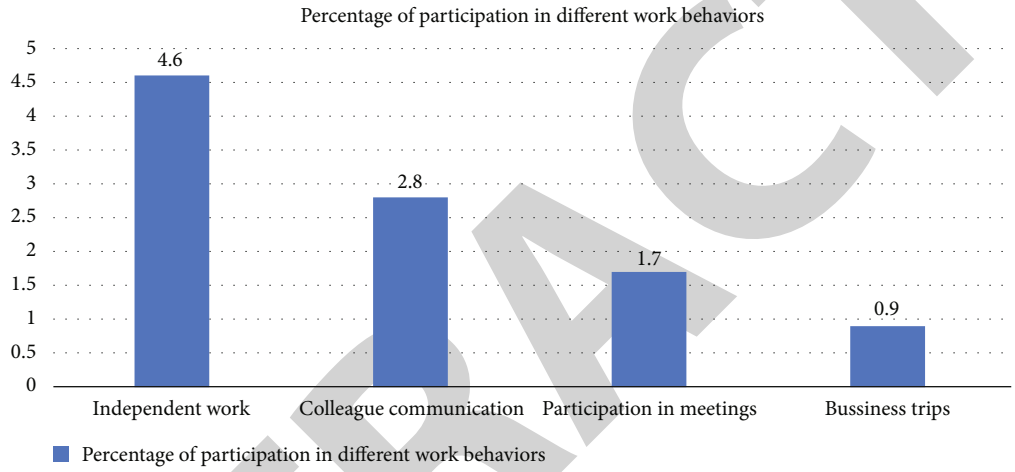

Figure 7: Proportion of workers engaged in other work behaviors in the course of work.

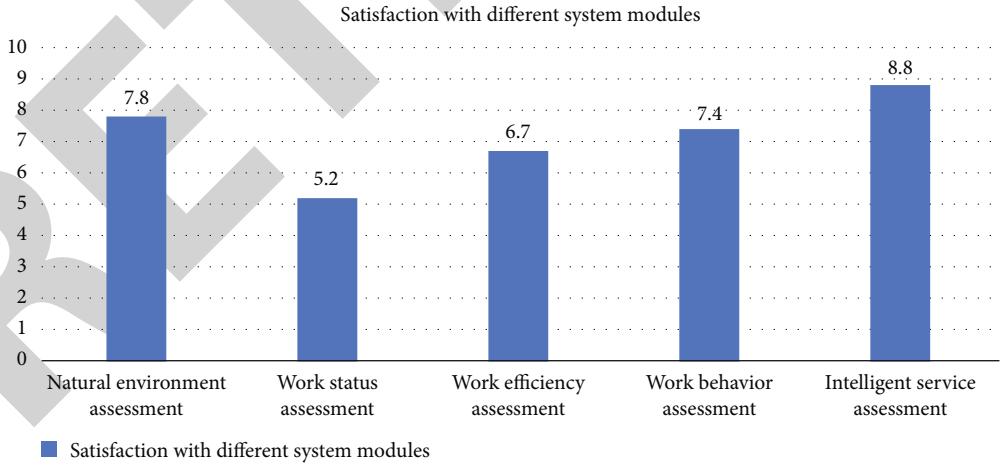

Figure 8: Satisfaction survey of each service of work environment design system.

of influence on workers' work efficiency as well as their physical and mental health as shown in Figure 3.

After the artificial intelligence algorithm evaluated and analyzed the natural working environment, the result graph shown in Figure 4 was obtained. Figure 4 shows the results of temperature, humidity, and noise environments with the highest work efficiency during the most efficient working hours, i.e., around 10 : 00 am.

According to Figure 4, we can get the following conclusions: for temperature between 20 degrees Celsius and 30 degrees Celsius, workers generally have higher work efficiency, as well as a more stable work mood compared to

other temperatures; humidity does not have a great degree of influence on workers, but if the humidity is too low, the human body will become dry and uncomfortable, which will damage the body, and too high humidity will produce a stifling feeling, which will reduce work efficiency. Relative humidity between 60% and 70% of the highest work efficiency: noise on the work efficiency of workers will have a greater impact; in addition to the abovementioned damage to the human body, too much noise will affect the ability of workers to think and work faster, interfere with the workers' work ideas, and interrupt the workers' work process; the workers have a great impact on the results of their work; working in a quiet, harmonious external environment, that is, the noise is less than 50 decibels, will have a more positive impact on workers' work efficiency and physical and mental health.

After the analysis of the AI algorithm, the results of the social environment assessment during the working hours are shown in Figures 5–7.

Among them, Figure 5 shows the frequency of using applications other than work during different time periods studied by the AI algorithm analysis, Figure 6 shows the work efficiency of workers in different time periods during work hours, and Figure 7 shows the proportion of workers involved in other work behaviors during the work process.

According to the survey, the most frequently used application outside of work is WeChat, followed by Jitterbug, and the frequency of microblogging is also very high among young workers. From Figure 7, we can see that workers are still working independently most of the time, but of course, they also need to communicate and discuss with colleagues, complete collaborative projects, attend meetings some of the time, and travel to perform tasks some of the time.

After the statistics of workers' working environment, working habits, and daily working style, based on these evaluation results, the intelligent service system can provide corresponding services for workers to improve their working environment, such as reminding workers to hydrate on time, to take a break from using computer too much, to set up green plants around the desk to purify the air, etc. According to workers' working habits, workers can be reminded to attend regular meetings, receive emails, participate in discussions, etc. In addition, the intelligent service system can also help workers order take-out, play music to soothe the body and mind, and remind workers to exercise. As shown in Figure 8, the satisfaction survey of workers with the services of the work environment design system is shown.

From the above figure, we can see that the workers are satisfied with the natural environment assessment and intelligent service system, but they are not very satisfied with the work status assessment and efficiency assessment. Some workers think that the work status assessment is not accurate enough, and the assessment is only one-sided by the length of time of using other applications and should be improved. Most of the workers are satisfied with the intelligent service system because it improves the efficiency of workers to a certain extent and helps them maintain a healthy body after work.

5. Conclusion

5.1. Summary. This paper is a new form of work environment designed by artificial intelligence algorithm, which reads the environmental factors of workers' work through sensors and uses big data to analyze and study various behaviors of workers at work, so as to evaluate the natural and social environment of workers' work and achieve the goals of supervising workers' work, improving workers' work environment, keeping workers in a better working mood, and improving workers' work efficiency. The purpose is to supervise workers, improve their working environment, keep them in a better mood, and improve their efficiency. The main work carried out is shown below.

(1) The basic types of work environments and their effects on workers are introduced

(2) The concept of artificial intelligence algorithm is introduced, and the history of the development of artificial intelligence algorithm is introduced through literature research and the importance of artificial intelligence algorithm to the present society

(3) The basic framework of the new form of work environment setting system is proposed based on AI algorithms, and the functions and tasks of each framework are outlined

(4) The artificial intelligence algorithm is used to evaluate the work environment of workers, and the intelligent service system is used to serve workers and help them face their work in a better state and mood and improve their work efficiency

(5) A survey was conducted on the satisfaction of workers using the work environment design system to collect opinions for further improvement in the future

5.2. Outlook. Since the emergence of artificial intelligence technology, more and more terminal devices have appeared in people's daily life. Artificial intelligence is increasingly penetrating into all corners of human life and social development, and this influence is increasing, and human productive life becomes more convenient because of artificial intelligence. On this basis, the deeper development of artificial intelligence will be able to create an artificial intelligence cyberspace based on digitalization, intelligence, and virtualization with the help of artificial intelligence technology to expand and enrich human production relations and life content.

With the continuous development of science and technology, the work content of workers is also constantly innovating and optimizing, which puts forward higher requirements for workers while also providing them with a better working environment, and a good working environment can stimulate better creativity. The new form of work environment design proposed in this paper is the use of artificial intelligence algorithms to build a better atmosphere for workers, and I believe that with the progress and optimization of

artificial intelligence algorithms, a more humane work environment will be created in the future.

The new form of work environment design proposed in this paper is the use of artificial intelligence algorithms to build a better atmosphere for workers, and I believe that with the progress and optimization of artificial intelligence algorithms, a more humane work environment will be created in the future. There are still some shortcomings in the new form of work environment designed by using AI algorithms proposed in this paper that can be improved.

First, the consideration of this paper is not comprehensive enough, there are many other aspects of the work environment that affect the work of workers, and different types of workers work in different environments; this paper only provides a work environment system for the office type of workers, not very suitable for workers who work outdoors.

Secondly, the system designed by artificial intelligence algorithm in this paper is the result obtained through big data analysis, which may not be completely accurate, and the satisfaction of the designed social environment assessment system is not high enough, and further optimization is needed.

In the long history of human development, people have continued to pursue their intelligence, creativity, and cognitive ability in depth, contributing to the development of artificial intelligence today. In today's society, AI has the great significance of fundamentally advancing the civilization of human society. The future path of AI, though obstructed and long, is bound to have exciting results.

Data Availability

The dataset is available upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Retraction

Retracted: Hybrid Encryption Algorithm for Sensitive Information of College Physical Fitness in Cloud Storage Environment

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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Research Article

Hybrid Encryption Algorithm for Sensitive Information of College Physical Fitness in Cloud Storage Environment

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In order to improve the security of college sports fitness sensitive information, this paper proposes a hybrid encryption algorithm for college sports fitness sensitive information in cloud storage environment. Build an analysis model of influencing factors of cloud storage environment to identify the risk value of sensitive information; Using Bloom filter data structure to eliminate redundant data of sensitive information; The transmission channel model of sensitive information and the security coding model of sensitive information are constructed. Combined with the fuzzy differential information fusion method, the complete key of sensitive information under the symmetric encryption protocol is obtained to realize the key optimization design. Through AES encryption and decryption algorithm, the anti encryption control and structural reorganization of college sports fitness sensitive information, and the iterative convergence control of hybrid encryption, so as to realize the hybrid encryption of college sports fitness sensitive information. The encryption time of the design algorithm under different attribute numbers is always kept below 0.2S, the maximum encryption time under different number of software packages is only 0.5 s, and the encryption accuracy can reach 1, which proves that the design algorithm has certain application value.

1. Introduction

With the development of sports fitness in Colleges and universities, the security of sports fitness data transmission has attracted more and more attention [1]. It is very important to establish an optimized control model for the transmission of physique sensitive information in Colleges and universities, and adopt optimized encryption algorithm to improve the encryption ability of physique sensitive information [2, 3]. Based on this, some scholars have studied it, For example, Wang l et al. [4] introduced a new IND-CCA secure multi instance framework for code based hybrid encryption primitives in random oracle model. This method is based on the direct construction of key generation function and one-way trapdoor function. The input is labeled to achieve more strict security loss and smaller private key size. F Hasan [5] proposed an algorithm based on hybrid supervised regression classification learning. The algorithm adopts the hybrid structure of classifier and regression learner to realize data encryption. The results show that the algorithm is faster than the original problem and has less computing resources. Z Yu Lei et al. [6] proposed a sensitive information encryption scheme based on format retention in the identity password environment. Compared with the existing format retention encryption scheme, the communication parties do not need to transfer the key, and generate the encryption key and decryption key through the key derivation function. The security of sensitive information transmission is improved by using hybrid encryption. It is proved that the scheme meets the security of identity based pseudo-random permutation and has the indistinguishability of ciphertext under adaptive selective plaintext attack. L Xiao Feng et al. [7] proposed an intelligent encryption algorithm for medical sensitive information based on quantum computing. Firstly, the key construction of quantum encryption of medical sensitive information is designed by considering the mixed entangled state, and the protocol subspace matrix constructed in the key is analyzed to form the key information Then, by calculating the neighborhood distribution function of information, the separation matrix quantum coding is constructed to provide processing data for key rearrangement. Considering the interference of quantum

entangled states and their additional states, effective key encryption is carried out, and finally the intelligent encryption of medical sensitive information is realized. The experimental results show that this method has good anti attack ability, high transmission efficiency and good overall performance. Although the above methods have realized the encryption of sensitive information or data, the algorithm is very complex and the security performance is low, so it is not suitable for the encryption of sensitive information of physical fitness in Colleges and universities with large amount of data.In order to solve the above problems, this paper proposes a hybrid encryption algorithm for college sports fitness sensitive information in cloud storage environment.

2. Preprocessing Sensitive Information of College Physical Fitness under Cloud Storage Environment

2.1. Identification of Sensitive Information of Physical Fitness in Colleges and Universities. There are many groups of data with different attributes and different sources in the cloud storage environment, which may become factors affecting the security of sensitive information. When these factors change suddenly, the sensitive information in college physical fitness does not have protective measures, so there are great management risks in the whole college physical fitness. When users pay attention to privacy, there are two measurement dimensions of information risk: severity and susceptibility. Combined with the sensitive information protection and management standard [8], the influencing factor analysis model shown in Figure 1 is constructed.

Use the model shown in Figure 1 to identify the risk categories of college sports fitness sensitive information in the cloud storage environment. First, identify the management risk, which is the risk problem caused by poor information management in the overall service process [9]. When such a situation occurs, the cloud storage server has monitoring interruption or server crash [10]. Secondly, identify technical risks. In the process of cloud storage service, due to the interception of malicious software, the server is attacked, the entire monitoring environment becomes extremely fragile, and the sensitive information of files exposed in the air is stolen by other clients. Finally, identify the risk of information disclosure. The confidentiality level of sports fitness information in some colleges and universities is high, which may store extremely important political, economic and cultural information. When the server is attacked, the leakage of such information will annoy many management departments and regions. Based on the above analysis, there are three main risk categories of sensitive information. The influencing factor analysis model constructed this time sets the information judgment data layer according to the above risk categories in advance, and uses the calculation process of the following formula to identify whether there are risks in sensitive information and identify the degree of risk. The formula is:

$$\begin{cases} F_i = \sum_{i}^{n} \lambda_i \\ R = \int_{F_i}^{Q} (F_i, H_{t+1} | H_t)\, dF_i \end{cases} \quad (1)$$

Where F_i represents the risk identification result; λ_i represents i different influencing factors obtained by the model; R represents value at risk; H_t andH_{t+1} represents the running state of cloud storage environment at time t and time t +1, respectively. According to the above formula, the influencing factor analysis model determines and identifies the category and risk degree of sensitive information, so as to provide reliable data for the setting of encryption level.

2.2. Eliminate Sensitive Information and Redundant Data. There is a large amount of redundant data in the physical sensitive information of colleges and universities, which affects the encryption speed of sensitive information [11]. Therefore, it is very important to eliminate redundant data in sensitive information before encryption. Bloom filter can be used to retrieve whether an element is in a set, so as to eliminate the data that does not belong to the set. Its advantage is that the spatial efficiency and query time are much better than general algorithms. Therefore, the process uses data structure bloom filter to reduce the file characteristics of sensitive information. It is known that the structure is obtained by mapping and compression of multiple hash functions, represents an independent data set by vector U, and judges whether the factors obtained by the influencing factor analysis model belong to this set. This structure uses m hash functions to calculate. These functions are $h_i, h_2, \cdots, h_m$, respectively. While calculating all hash function values [12], set the array value of the corresponding n-bit length to 1. When using Bloom filter structure to search redundant data, use the same hash function to obtain m hash results. When there is a value not 1 in the m bit of the corresponding n-bit array, it can be determined that the data sequence does not belong to the rule set. When the results are all 0, the misjudgment rate p is used to determine that the data sequence belongs to the rule set. According to the above assumptions, the bloom filter data structure is constructed. The specific process is as follows:

Set the number of bits to k, and the initial value of all bits of the bloom filter data structure should be 0; Select two hash functions and record them as h_1 and h_2, respectively, to perform the data mapping task; Use two sets of functions to calculate the summary value under each identifier, and set the bit position of the data structure to 1; Output the result of Bloom filter as the characteristic value of sensitive information file. According to the above steps, determine the number of common 1 of these sensitive information files in bloom filter according to the similarity index of the two files. Referring to the calculation method of cosine similarity [13],

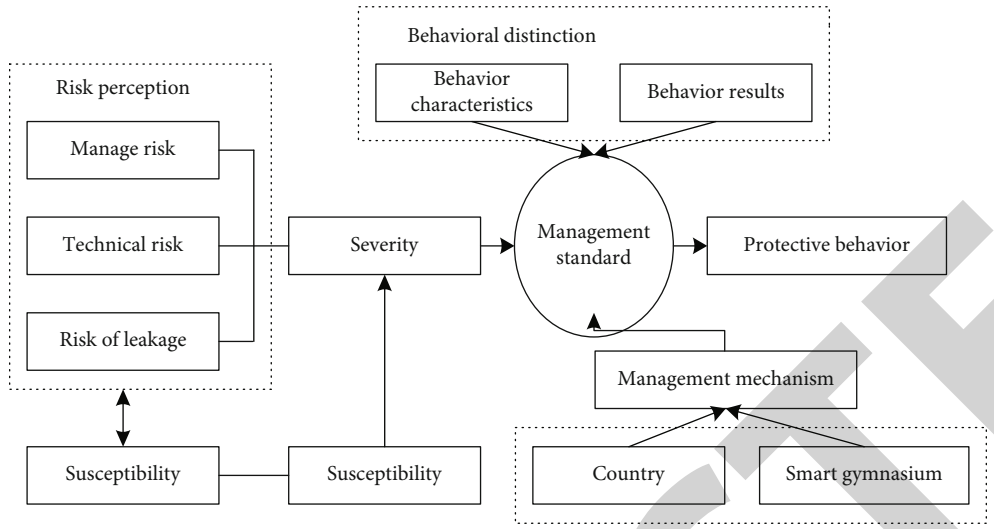


Figure 1: Analysis model of influencing factors of cloud storage environment.

the document similarity index is obtained, and the calculation formula is:

$$\mathrm{Sim}(u, v) = \frac{\sum_{i=1}^{n} u_i v_i}{\sqrt{\sum_{i=1}^{n} u_i^2 \sum_{i=1}^{n} v_i^2}} \quad (2)$$

Where u and v represent different sports fitness information sensitivity documents. When m hash functions map all elements to different arrays, the probability that a bit in these arrays is still 0 can be calculated by the following formula:

$$\dot{r} = \left(1 - \frac{1}{n}\right)^{ms} \quad (3)$$

Where 1/n represents a bit probability of a random hash function; $(1 - 1/n)$ indicates the probability that this bit is not recognized after one calculation. Therefore, in order to realize all data mapping, perform ms-th hash calculation to obtain:

$$\lim_{n \longrightarrow +\infty} \left(1 - \frac{1}{n}\right)^{-n} = \mu^{ms} \quad (4)$$

If the proportion of 0 in the array is γ, the error rate is calculated as follows:

$$(1 - \gamma)^m \approx (1 - r)^m \quad (5)$$

Where $(1 - \gamma)$ represents the proportion of digit group 1; $(1 - \gamma)^m$ represents the area where 1 is just recognized, so the value of misjudgment rate p is obtained:

$$p = \left(1 - \mu^{-(ms/n)}\right)^m \quad (6)$$

Using the above calculation process, the redundant data in the sensitive information file is determined and eliminated, which provides a prerequisite for fast encryption.

2.3. Mixed Encryption of Sports Fitness Sensitive Information

2.3.1. Sports Fitness Sensitive Information Coding. In order to realize the hybrid encryption of sensitive information about physical fitness in Colleges and universities in the cloud storage environment, first, build a key protocol for the encryption of sensitive information about physical fitness in Colleges and universities. Combined with the arithmetic coding method and key design [14], establish a link layer transmission protocol for sensitive information about physical fitness in Colleges and universities. Since the wheel code is the first practical and feasible code that can approach the Shannon limit, it has superior performance under the condition of low signal-to-noise ratio, And it can be applied in many fields. Therefore, this paper uses turbo coding as the coding sequence [15], and combines the methods of key recombination and packet forwarding to obtain the transmission channel model of university sports fitness sensitive information, as shown in Figure 2.

In the transmission channel structure model of sports fitness sensitive information in Colleges and universities shown in Figure 2, the chaotic modulation method [16] is used to obtain the encrypted sensitive transmission coding sequence. Through the fuzzy chaotic key control method, the delay D_{t+1} and captain sequence L_{t+1} of mixed encryption of sports fitness sensitive information at t+1 time are solved, and the expression is as follows:

$$\begin{aligned} D_{t+1} &= \delta_{t+1}(1 - \lambda)^2 \int_{t+1}^{t} f(t+1)dt \\ L_{t+1} &= \lambda(t+1) + \delta_{t+1} \int_{t+1}^{t} f(t) + f(t+1)dt \end{aligned} \quad (7)$$

Where δ_{t+1} is the sensitive coding sequence in the sensitive information transmission channel structure.

In the process of user key generation, analyze the symmetric key of college sports fitness sensitive information. Through the method of output key encapsulation, the input

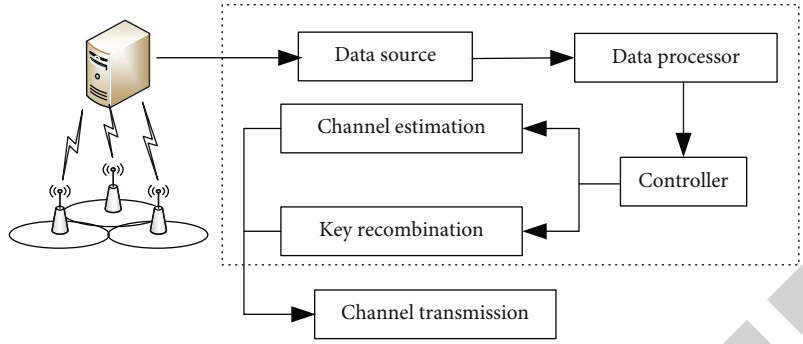


Figure 2: Transmission channel model of sensitive information of physical fitness in Colleges and Universities.

Table 1: Simulation test environment.

Name	Explain
Virtual machine	VM10.0
Processor	AMD A4-4300M 2.5GHz ×1
Memory	3GiB
Graphical	AMD
Hard disk	50GB
Operating system	Ubuntu 15.04 64bits
Kernel version	3.19.0-15-generic
Search engine toolkit	Lucene2.4.3

security parameters are as follows:

$$A = \lambda \sqrt{D_{t+1} - \frac{L_{t+1}}{\delta_{t+1}(t)}} \tag{8}$$

Define the length of the sensitive information of physical fitness in Colleges and universities to be encrypted as N, construct the sensitive characteristic quantity of physical fitness in Colleges and universities by using the symmetric hash function [17], use the distribution of 0 and 1 to carry out the error correction control of physical fitness encryption in Colleges and Universities, and obtain the transmission protocol of sensitive key of physical fitness in Colleges and universities according to the input system parameters:

$$\begin{aligned} C &\longrightarrow S : \text{Certificate A} \\ C &\longrightarrow S : \text{Exchange } D_{t+1} - N \\ C &\longrightarrow S : \text{Verify } L_{t+1} + N \end{aligned} \tag{9}$$

Using the method of symbol frequency feature decomposition, the security coding model of college sports fitness sensitive information is obtained as follows:

$$T_{service} = \sqrt{\lambda A} + \frac{\varepsilon_S + \lambda_S}{\rho} \tag{10}$$

Where ε_S is the characteristic component of cloud storage, λ_S is the covariance function [18], and ρ is the symbol frequency of college sports fitness sensitive information.

After obtaining the security coding model of sports fitness sensitive information in Colleges and universities, the key design of sports fitness sensitive information is realized by using the method of public key replacement.

2.3.2. Key Design of Sports Fitness Sensitive Information. Firstly, the method of replacing identity is used to mark the physical fitness key linearly, and the parameter information entropy of college physical fitness sensitive information is $H_2(x)$. The method of role distribution convergence key control is used to decrypt the private key, and the convergence key ciphertext is:

$$K = \frac{[\beta_2(x) + \alpha_2(x)]^2}{H_2(x)} \tag{11}$$

Where $\beta_2(x)$ represents the encryption symmetry function of sensitive information of physical fitness in Colleges and universities, and $\alpha_2(x)$ represents the Gaussian distribution function satisfying variance α. Using the method of convergent key control, a new transmission sequence $X = x_1, x_2, \cdots, x_n$ of college sports fitness sensitive information is constructed, and the binomial of sequence X is counted. It is obtained that the normal distribution characteristic quantity of college sports fitness sensitive information meets:

$$F = k(w) + \frac{X}{\theta} \tag{12}$$

Where k(w) is the probability density function of non overlapping block matching; θ distributes the convergence key for the role.

Using the method of differential fusion analysis, the identification bit of college sports fitness sensitive information data block is obtained, which is expressed as:

$$X_i = FK \sqrt{D_{t+1} - \frac{L_{t+1}{}^{w}}{\delta_{t+1}(t)}} \tag{13}$$

Where w is the amount of recoverable data files.

Based on the identification bit of the sensitive information data block and combined with the fuzzy differential information fusion method, the complete key of college

Table 2: Sharing performance parameters of different sensitive information encryption methods.

Sharing scheme	Test group a	Test group b	Test group c	Test group d
Attribute hiding	√	—	—	—
Property undo	√	—	—	√
User revocation	√	√	√	√
Computing outsourcing	√	—	—	√
Fine grained access	√	√	√	√
Sharing mode	Many to many	One to many	One to many	One to many

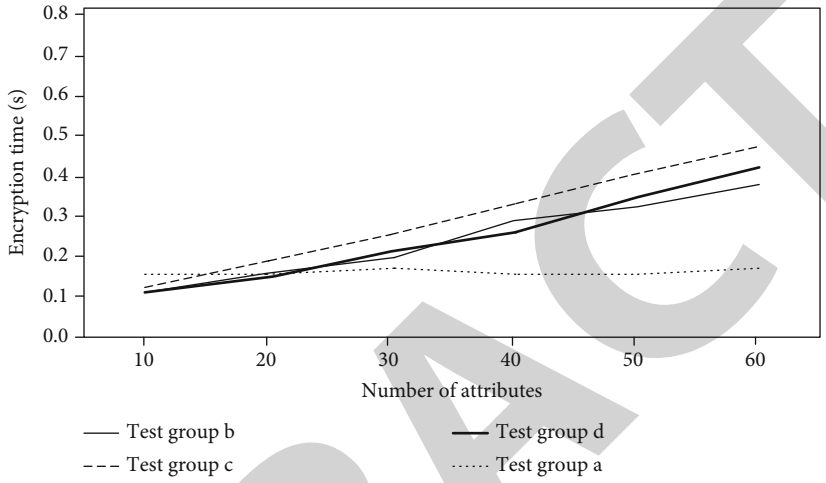


Figure 3: Encryption time under different attribute numbers.

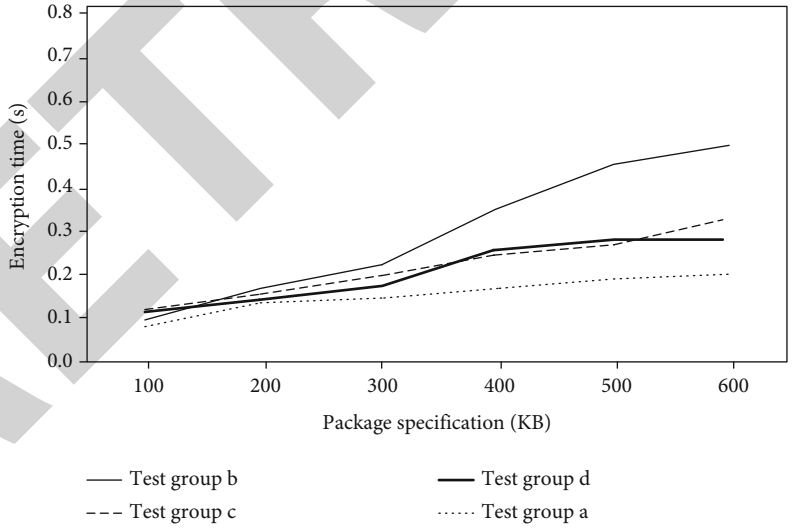


Figure 4: Encryption time under different package specifications.

sports fitness sensitive information under the symmetric encryption protocol is obtained, which is expressed as:

$$\sigma = \mathrm{Sim}(u, v)T_{service} + (X_i + 1)^2 \quad (14)$$

Observe the mixed encryption strength and complete the key design of sports fitness sensitive information, so as to improve the ability of data encryption transmission and privacy protection.

2.4. Optimization of Mixed Encryption of Sports Fitness Sensitive Information

2.4.1. AES Encryption and Decryption Algorithm. In the process of AES(Advanced Encryption Standard) encryption, the

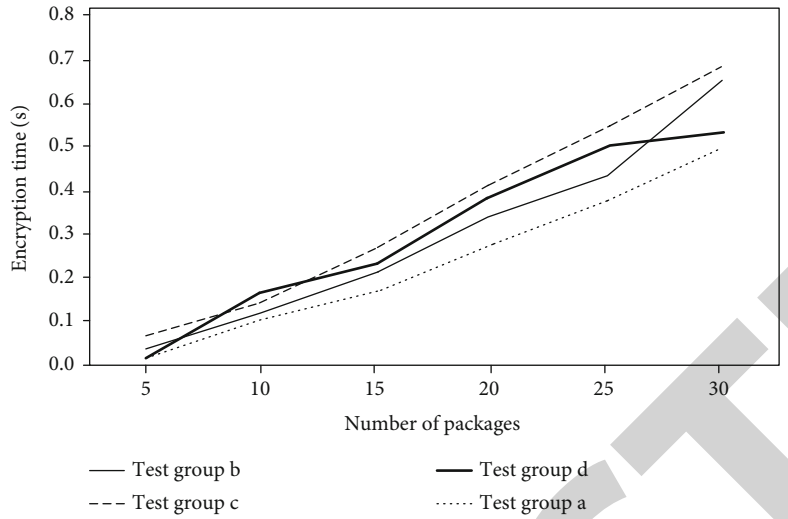


Figure 5: Encryption time under different number of packages.

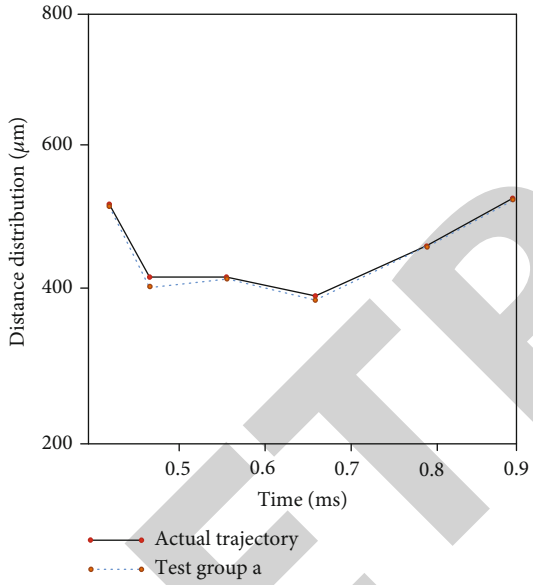


Figure 6: Data encryption output trace line.

statistical characteristic P is obtained by performing the frequency detection in the block. The key protocol of linear encryption is obtained by using the methods of chaotic homomorphic mapping [19] and elliptic linear encryption, which is expressed as:

$$G(x) = \sigma_{service} + PX_i \tag{15}$$

Thus, it is obtained that the output discrete statistical characteristic quantity of the encryption of college sports fitness sensitive information is described as:

$$C = \Delta H + F\int_{X=1}^{N} G(X)dx \tag{16}$$

When the length of the bit sequence is n and the block length is m, after obtaining the corresponding block length parameters, the random probability characteristic distribution of college sports fitness sensitive information encryption is obtained as follows:

$$V = C\int_{i=1}^{n} \frac{1}{\Delta H}\sum_{i=1}^{n} u_i v_i di \tag{17}$$

Under the key protocol of linear encryption, the statistical characteristics of frequency detection in the block are obtained. According to arithmetic coding and chaotic key control, the AES encryption algorithm for the statistical characteristics of sports fitness sensitive information is as follows:

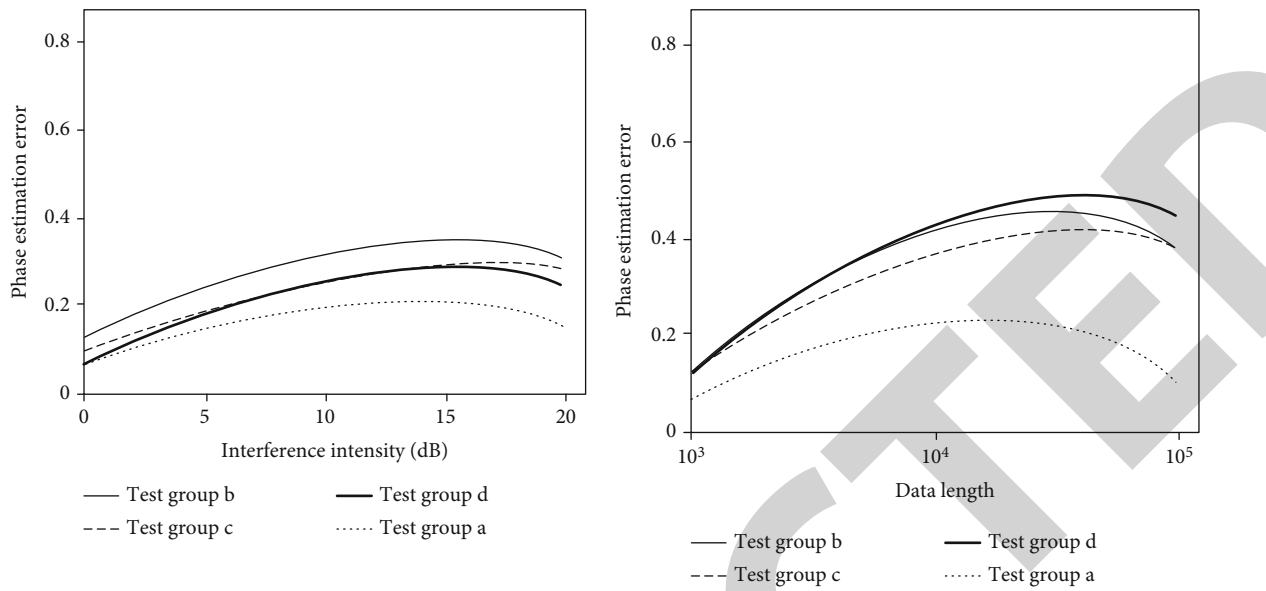
$$W_{service} = G(x)\sqrt{\frac{V}{2}} \tag{18}$$

Assuming that the chaotic encrypted copy of the heterogeneous cryptosystem is J, under the adaptive ciphertext attack, the decryption algorithm of sports fitness sensitive information is as follows:

$$Y = A(W_{service} + \sigma_{service})^2 \tag{19}$$

According to the above calculation results, the optimization design of AES encryption and decryption algorithm is realized.

2.4.2. Mixed Encryption of Sports Fitness Sensitive Information. Through AES encryption method [20], the anti encryption control and structural reorganization of college sports fitness sensitive information are carried out, and the measurement information of college sports fitness sensitive



(a) Different interference intensity

(b) Different data length

Figure 7: Comparison of estimation errors of sensitive information.

Table 3: Comparison of detection and recognition accuracy (%).

Number of experiments	Test group a	Test group b	Test group c	Test group d
20	0.923	0.823	0.575	0.765
40	0.989	0.856	0.789	0.794
60	1.000	0.894	0.896	0.817
80	1.000	0.894	0.918	0.852

information meets the following requirements:

$$r_{imax} = \frac{n + Y}{2^{imax+2}} \tag{20}$$

Where imax is the longest convergent key ciphertext.

In the longest frequency detection model, the frequency of imax and AES encryption is r_{imax}. assuming that the private key of the data block and the identification component of the data block are represented by M, the hybrid encryption iterative function of university sports fitness sensitive information encryption is obtained as follows:

$$Z = \text{sum}(\text{imax}) + \frac{\sqrt{r_{imax}}}{N} \tag{21}$$

Combined with the hybrid encryption iteration, the detection statistics shall meet the following convergence control form:

$$\varphi = Z - 2n\pi(1 - \pi) \tag{22}$$

Under the optimized encryption block length, the statistical characteristic quantity of linear encryption key is obtained, which is expressed by ω and obeys the standard normal distribution function. Finally, the data ciphertext and convergence key are sent to the encryption key, and the mixed encryption model of sports fitness sensitive information is obtained as follows:

$$E = \frac{1}{\omega}\sum_{n=1}^{N}\left[Z + \frac{n\pi(1-\pi)}{Y}\right] \tag{23}$$

This paper realizes the hybrid encryption of sports fitness sensitive information, and completes the design of sports fitness sensitive hybrid encryption algorithm in Colleges and universities by using AES encryption and decryption algorithm.

2.5. Simulation Test Analysis. In order to verify the effectiveness of the proposed hybrid encryption algorithm for college sports fitness sensitive information in cloud storage environment, the simulation test is carried out on MATLAB tool.

2.5.1. Simulation Preparation. The setting of simulation test environment parameters is shown in Table 1.

Assuming that the test environment under the parameters in Table 1 is stable and safe, test the hybrid encryption performance of the proposed method for sensitive information in the process of college sports fitness information sharing. In order to ensure that the experimental test results can fully explain the effectiveness of the data, this method is compared with the existing three groups of encryption methods in reference [5], reference [6] and reference [7], and three groups of comparative encryption methods are set as Test group b, Test group c and Test group d, respectively. The proposed method is Test group a, and Table 2 shows the shared performance parameters of the four groups of encryption methods.

In Table 2, attribute hiding means that when the user accesses the shared data, the random attributes not associated with the attribute information are difficult to identify the pairing. Even if the attacker obtains the value, it does not know the data attribute Association, so it has the hiding function. Attribute revocation when users need to revoke attributes, they can use cloud sending to delete the attribute set stored locally. User revocation means that the user needs to revoke and send the data to be deleted by using the private cloud to realize user deletion. Computing outsourcing is the process of sharing data. Private cloud generates ciphertext. Through computing outsourcing, the complexity of the signature algorithm is reduced and the amount of computation is reduced. Fine grained access is to design corresponding restriction conditions for each shared data, and determine the access users through the conditions.

3. Results and Analysis

In order to ensure that the test results are more convincing, the number of 60 access attributes is set in the first stage of the experiment. Figure 3 shows the encryption time test results of four groups of encryption methods under the same test conditions.

According to the test results shown in Figure 3, as the number of attributes increases during the access process, the encryption time of test group B and test group candtest group increases, while there is no obvious correlation between the encryption time of test group A and the number of attributes. Although the number of attributes continues to increase, the encryption time has been in a stable state, always kept below 0.2S, which proves that the encryption efficiency of the design method is higher. The reason for this phenomenon is that the encryption process of the four groups of encryption methods is different. Compared with the three encryption methods, the calculation is more complex, so it takes longer time. In the second stage of the experiment, different file packages are set. Figure 4 shows the encryption time test results under different file package specifications.

According to the test results shown in Figure 4, when the file package specifications are different, the encryption time of all methods increases with the increase of the file package volume. Among them, the encryption time of Test group b is the highest, and the encryption time of the other three groups is relatively close, but generally speaking, Test group a of the method in the representative text takes the least time. This is because test B needs to block the data before encryption. Therefore, when the volume of the file package is larger, the more blocks need to be divided and the longer the time will be. In the third stage, set different number of packages. Figure 5 shows the encryption time test results of four groups of methods under different number of packages.

According to the test results shown in Figure 5, the encryption time of the four groups of methods increases rapidly with the increase of the number of packets. However, compared with the other three groups, the encryption time of the test group is the shortest, and the maximum is only 0.5 s, which is far lower than the encryption time required by the other three methods. Therefore, it is proved that under the conditions of the third test stage, the encryption method proposed in this paper is slightly better than the other three groups of encryption methods.

The length of sensitive information of physical fitness in Colleges and universities is 1600 μm. The length of the block is 200 points μm. The packet size is 120 μm. The transmission delay of sports fitness sensitive information is 0.67 ms, and the size of data file is 12GB. The distribution of data encryption track line is shown in Figure 6.

According to the analysis of Figure 6, the output stability of the sensitive information encryption of college sports fitness by this method is high, which is basically consistent with the encryption track, and can improve the encryption ability of sensitive information.

Test the phase estimation error of sports fitness sensitive information under different data interference intensity and different data length. In order to enhance the statistical convenience of the experimental results, set the error unit as unit 1, and the results are shown in Figure 7.

When the error of the three groups of interference (a) is 2.0, it is known that the error of the four groups of interference (a) in the simulation method increases by 2.0. Compared with the four groups of interference, when the error of the three groups of interference (a) is the largest in the test process. The experimental results in Figure 7(b) show that when the data length increases, the sensitive information recognition errors of the three methods are quite different. In contrast, the application of test group a was least affected by the data length. The above experimental results show that the identification error of sensitive information in test group a is low, and the application stability is strong.

In order to further verify the application accuracy of Test group a, test the accurate recognition rate of different methods under fixed interference intensity and data length. The number of experimental iterations is 80 times, and the accuracy unit is 1. The specific output data results are shown in Table 3.

Analysis of Table 3 shows that when the interference intensity and data length are the same, the recognition accuracy of Test group b also improves with the increase of the number of experimental iterations, but the highest accuracy is 0.894, which can not meet the requirements of encryption of sensitive information of physical fitness in Colleges and universities. When the number of experiments reaches 80, the recognition accuracy of Test group c reaches 0.918, but when the number of experiments is small, the accuracy of this method is $0.5 \sim 0.8$, indicating that the application of this method is not stable enough and the recognition accuracy fluctuates greatly. The test accuracy of group D fluctuated between 0.76 and 0.86, which was relatively stable, but the accuracy was still lower than that of group A. The accuracy of Test group a is high. When the number of experiments reaches more than 60, the recognition accuracy of Test group a reaches the highest value, which shows that under the support of the number of experiments, the method achieves the best stability and application performance.

4. Conclusions

In order to improve the security of college sports fitness data transmission, this paper proposes a hybrid encryption algorithm for college sports fitness sensitive information in cloud storage environment. Using turbo code as the coding sequence, combined with the methods of key reorganization and packet forwarding, the transmission channel model of college sports fitness sensitive information is obtained. According to the mixed encryption strength and combined with the fuzzy differential information fusion method, the representation of college sports fitness sensitive key and the transmission protocol of college sports fitness are constructed to realize the mixed encryption of college sports fitness sensitive information encryption and secret stealing. The encryption time of the design algorithm under different attribute numbers is always kept below 0.2S, the maximum encryption time under different number of software packages is only 0.5 s, and the encryption accuracy can reach 1, which proves that the design algorithm has certain application value. Based on the above research, it can be proved that the algorithm designed in this paper has a good application and development prospect in the field of sensitive information encryption of physical fitness in Colleges and universities, and is also of great significance to sensitive information encryption in other fields. However, the algorithm did not analyze the encryption effect of sensitive data in other fields during the experiment. Therefore, if you want to extend it to more fields, you need further experimental analysis to optimize the shortcomings of the algorithm and realize its application in many fields.

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Research Article

A Face Recognition Method Based on Multifeature Fusion

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Face recognition is widely used in daily life and has an important supporting role for social management. Face recognition is mainly based on historical accumulation data to confirm people's identities in unknown samples and obtain valuable intelligence information. For the problem of face recognition, this paper proposes a multifeature joint adaptive weighting algorithm framework. In this method, a number of different types of features are first used to describe the face characteristics. The selected features should be as complementary as possible, and the overlap redundant information should be reduced to the greatest extent, so as to ensure the performance and efficiency of multifeature fusion. In the classification stage, based on the joint sparse representation model, the multiple types of features are characterized, and their reconstruction error vectors for the corresponding features of the test sample are calculated. The joint sparse representation model can examine the correlation between different types of features, thereby improving the accuracy of representation and fully integrating the advantages of multiple types of features. At the same time, in view of the simple superposition of reconstruction errors in the traditional sparse representation model, this paper uses a random weight matrix to comprehensively consider the weighted reconstruction errors under different weight conditions, so as to obtain statistical decision quantities for the final decision. The framework proposed in this paper can adapt to different multifeature combinations and has good practicability. In the experiment, training and test sets are constructed based on public face image data sets to test the proposed method. The experimental results show that the method in this paper is more effective and robust compared with some present methods for face recognition.

1. Introduction

In the recent COVID-19 epidemic, the face recognition system has played an important role in quickly confirming the identities of people and improving the effectiveness of joint prevention and control. Face recognition is a widely studied problem in pattern recognition [1–4]. Face recognition is a traditional supervised classification problem, in which a reliable classifier is obtained under the training of some labeled samples, and the samples of unknown categories are confirmed. Under the framework of pattern recognition, this paper focuses on the research of face image recognition, that is, confirming the people's identities based on the acquisition of face images. Judging from the existing literature, the general pattern recognition methods can generally be divided into two stages: feature extraction and classification. Feature extraction is used to obtain various features of the objects in face images, such as principal component analysis (PCA), Zernike moments of the target area, Gabor texture, and histogram of oriented gradients (HOGs), so as to achieve the goal of describing high-dimensional images with low-dimensional feature vectors [5–8]. In the classification stage, it is mainly to select a suitable classifier to process the result of feature extraction and obtain its corresponding object category. Common classifiers include K nearest neighbors (KNN), support vector machines (SVM), and sparse representation-based classification (SRC) [9–13]. In recent years, deep learning algorithms have become an important tool in remote sensing image target detection and recognition and have been widely used and verified [14–18].

In traditional face recognition methods, a single category of features is usually used in the feature extraction stage. In fact, the scenes acquired by face images are relatively complex, and the characteristics of a single type of feature are often difficult to fully describe the characteristics of the object. In addition, the adaptive recognition scenes are very limited. For this reason, researchers have developed the multifeature decision fusion for the problem of face recognition

[18–20]. Judging from the reported results, the joint application of multiple features can effectively improve the performance of face recognition, which has advantages over a single category of features [21–25]. However, the current multifeature fusion method has certain shortcomings. One is that the relevance of multicategory features is not fully utilized. For the different types of characteristics of the same object, there are mutual differences (complementarity) between them, but also a certain correlation. For example, in each type of feature space, the correlation between the features of the test samples and the features of different training samples tends to be the same. Therefore, making full use of this inherent correlation can further utilize the advantages of various features. Second, in the decision-making combination of different features, the same weight is usually used, that is, the importance of different features to the recognition result is considered to be the same. In fact, in different recognition scenarios, the advantages of various features are often different, and methods with equal weights have certain disadvantages. Considering the above shortcomings, this paper proposes a multifeature joint adaptive weighting decision fusion framework for the problem of face recognition. Aiming at the problem of insufficient relevance of multiple types of features, this paper uses joint sparse representation [17, 18] to represent the multiple types of features of face images, so as to use their relevance to improve the reconstruction accuracy. For the problem of equal weighting, this paper adapts to the reconstruction error of different feature outputs, by constructing a random weight matrix, using multiple sets of different weight vectors for weighted fusion. Considering fusion results of a large number of weight vectors, this paper constructs statistics based on the mean and variance and constructs the final decision variables based on them, which is used to identify different types of objects in face images. The experiment further constructs training and test samples containing multiple types of targets based on the public face image data sets. Then, the proposed method is tested and compared with some existing face recognition methods. The experimental results reflect the effectiveness and robustness of this method.

2. Multifeature Joint Representation

The traditional sparse representation model is mainly for a single input. On this basis, a sparse representation classification algorithm is derived, and it has been widely used and verified for target recognition problems such as faces and vehicles. The joint sparse representation model can be considered as a multitask form of sparse representation, with the ability to simultaneously represent multiple inputs [17, 18]. At the same time, through appropriate correlation constraints, the joint representation accuracy of multiple inputs can be effectively improved. Specifically in this article, the joint sparse representation is employed to analyze and process multiple features of face images. Assuming that the K different features of the test sample y are $y^{(1)}$, $y^{(2)}$, …, $y^{(K)}$, they are sparsely represented as follows:

$$\min_{\beta}\left\{ g(\beta) = \sum_{k=1}^{K}\left\| y^{(k)} - A^{(k)}\alpha^{(k)} \right\| \right\}. \tag{1}$$

In equation (1), $A^{(k)}$ is the dictionary corresponding to the kth feature, which is generally constructed by the feature vectors from the training samples; $\alpha^{(k)}$ is the corresponding sparse representation coefficient vector; $\beta = [\alpha^{(1)}\ \alpha^{(2)} \cdots \alpha^{(K)}]$ is the coefficient matrix, which contains the sparse representation coefficient vectors of different features.

Although the above optimization goals achieve formal unity, they are not substantially different from solving each sparse representation problem independently. For this reason, the joint sparse representation model is modified based on equation (1) and appropriately constrains the coefficient matrix β to construct a new objective function as follows:

$$\min_{\beta} g(\beta) + \lambda\|\beta\|_{2,1}. \tag{2}$$

Under the constraint of the ℓ_1/ℓ_2 norm, the sparse coefficient vectors of different types of features tend to have similar distribution rules, thereby reflecting the correlation between them and improving the overall representation accuracy.

Based on the solved sparse coefficient matrix, the joint sparse representation model makes the object label decision according to the minimum error criterion in equation (3).

$$\text{identity}(y) = \min_{i} \sum_{k=1}^{K}\left\| y^{(k)} - A_i^{(k)}\alpha_i^{(k)} \right\|, \tag{3}$$

where $A_i^{(k)}$ and $\alpha_i^{(k)}$ are the local dictionary and coefficient vector corresponding to the ith class in the kth feature space, respectively.

The decision criterion in equation (3) actually believes that different types of features have the same importance for the final recognition result, so it is only a simple error accumulation. In the application of actual face recognition, due to changes in acquisition conditions and changes in the environment, different types of features may have different importance. Therefore, the traditional method of error summation with equal weights has certain limitations. It is necessary to find adaptive weights to take advantage of different types of features.

3. Decision Fusion

As mentioned above, the decision of the traditional joint sparse representation model can be considered as the result of equal weight fusion, and the characteristics and advantages of different inputs are not fully utilized. To this end, this paper uses multiple sets of random weight vectors for decision fusion, which together form a random weight matrix W as follows:

$$W = \begin{bmatrix} w_{11} & w_{12} & \cdots & w_{1N} \\ w_{21} & w_{22} & \cdots & w_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ w_{K1} & w_{K2} & \cdots & w_{KN} \end{bmatrix}, \tag{4}$$

where each column in the matrix corresponds to a random weight vector, and the elements satisfy the following constraints:

$$\sum_{k=1}^{K} w_{ki} = 1, w_{ki} \geq 0. \tag{5}$$

Assuming that the error obtained from the reconstruction of the kth feature of the type using the ith local dictionary of the type is r_k^i, the weighting process of a set of weight vectors in the random matrix is described as follows:

$$R_n^i = \left[r_1^i\ r_2^i \cdots r_K^i\right] \begin{bmatrix} w_{n1} \\ w_{n2} \\ \vdots \\ w_{nK} \end{bmatrix}. \tag{6}$$

For a random weight matrix containing N random weight vectors, the ith class can obtain corresponding results to form a fusion error vector $R = [R_1^i\ R_2^i \cdots R_N^i]$.

Each constraint in the random weight vector has strong randomness under the condition of satisfying equation (5). With the continuous increase in the scale of the weight vector, the fusion error vector can be well reflected in the dominance of different features. Therefore, the relevant statistical value of the fusion result can better reflect the decision result of multitype feature fusion. The decision variable constructed in this paper for face recognition is as follows:

$$J = m + \lambda\sigma. \tag{7}$$

In equation (7), m and σ are the mean and variance of a certain category of fusion error vector, respectively; λ is the adjustment parameter. Correspondingly, for C different training categories, the corresponding C decision variable values can be calculated accordingly, which are recorded as $J_1, J_2, \cdots, J_C$. According to the definition of the decision variable, when it is smaller, the reconstruction error is smaller and tends to be stable. Therefore, the probability of the test sample belonging to this category is greater at this time. Therefore, this article compares the values of decision variables in different categories and considers that the category with the smallest value is the target category of the test sample. Based on the above discussion, the key steps of the method in this paper are shown in Figure 1, which can be specifically described as follows. First, multitype feature extraction is performed on all test samples, and a corresponding dictionary is constructed. Secondly, the corresponding multitype characteristics of the test sample are obtained. Then, the joint sparse representation is used to calculate the reconstruction errors of different categories for various features. Finally, a random weight matrix is constructed, and the decision variables corresponding to each category are calculated to determine the target category of the test sample.

4. Experimental Results

4.1. Data Sets. In this paper, the Yale-B face image data set is used for the performance evaluation of the proposed method. The data set includes 45 facial images from 10 people, each of which is acquired under different lighting conditions. The image size is 32 pixels × 32 pixels. Figure 2 shows some exemplar samples from the data set. In the experiment, 20 images of each person are randomly selected for training, and 25 samples are left as test samples.

This paper focuses on designing a framework for multifeature fusion recognition of face images and does not clarify the types and forms of multifeatures. For this reason, in the experiment process, it is mainly compared with the existing multifeature (classifier) fusion method. Specifically, the first comparison method is the joint sparse representation model (denoted as JSR). This method is consistent with the general idea of this article, but after the joint sparse representation, random weight fusion and statistical analysis decision-making are not performed. The second comparison method is based on the D-S evidence theory (denoted as DS) [15]. The decision results of different features (classifiers) are fused based on D-S. The third method uses a voting mechanism (denoted as voting) [16] for different features (classifiers). The result of the decision is processed. For these methods, this paper selects three typical faces based on the existing literature, namely, Zernike moment, HOG feature, and Gabor feature. These three types of features can, respectively, reflect the target geometry, local texture, and spectral characteristics, so they have a certain degree of complementarity.

4.2. Results and Discussion. The experiment is first carried out based on the original test samples. Table 1 compares the test results of several decision fusion methods on the original samples. It can be seen that the average recognition rate of the method in this paper is the highest, reflecting its performance advantages. Compared with the method of directly using the joint sparse representation model, the method in this paper increases the average recognition rate by 2.31% through further random weight fusion and statistical analysis. The improvement effect is significant. Compared with the D-S fusion and voting method, the fusion mechanism in this paper has obtained a higher recognition rate, reflecting its advantages. Table 1 also compares the average time consumptions of different methods for a single test sample. Due to the introduction of random weight processing, the efficiency of this method is slightly lower than that of the joint sparse representation method. Since the weighting process of random weights is a linear operation, the efficiency reduction is not obvious. The other two types of decision fusion methods involve the combined use of multiple features and classifiers, so the time cost is significantly increased. In summary, the method in this paper has strong advantages for face recognition problems.

The actual collection process of the face image may be interfered by different degrees of noises, resulting in a low signal-to-noise ratio (SNR) of the test sample to be identified. This experiment mainly investigates the recognition performance of the proposed method under early noise

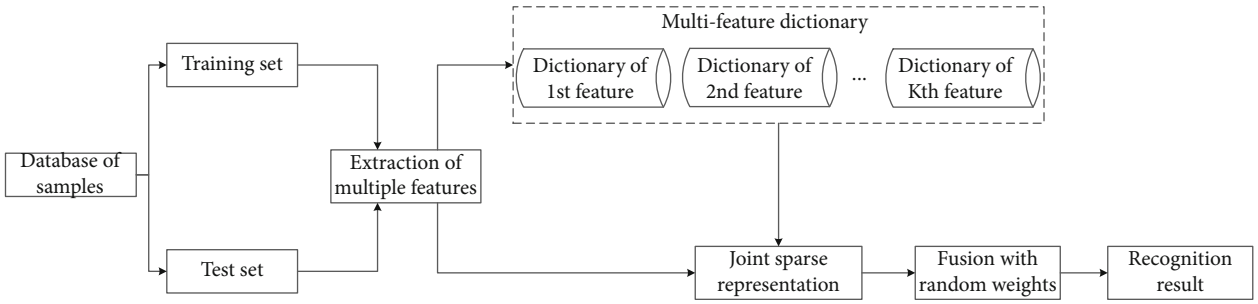

Figure 1: Basic flow of the proposed method in this paper.

Figure 2: Examples of face images in Yale-B data set.

Table 1: Recognition performance of different methods on original samples.

	Method type			
	Proposed	JSR	D-S	Voting
Average recognition rate (%)	96.8	94.5	95.7	95.1
Average time consumption (ms)	79.5	76.3	92.4	89.6

Table 2: Performance of different methods on noisy samples (%).

	SNR				
	-10	-5	0	5	10
Proposed	72.1	79.2	85.1	89.9	95.4
JSR	66.5	73.6	77.8	84.6	92.3
D-S	67.0	74.1	78.4	84.8	92.4
Voting	68.1	76.3	81.4	86.6	93.4

interference conditions. Specifically, first, the noise simulation is performed on the original test samples according to the relevant ideas in the literature [14] to obtain test sample sets with different noise levels. Then, the proposed method and the comparison method are used to identify test samples with different SNRs. Their results under different noise levels are shown in Table 2. From the overall trend, all the methods are affected by noise interference to varying degrees, and there is a significant performance degradation. In contrast, the proposed method can maintain performance advantages under different noises and shows stronger noise robustness. With random weights and statistical analysis, the advantages of various features for noise interference can be fully utilized. At the same time, the optimization processing of the joint sparse representation solution process also reduces the influence of noise to a certain extent, thereby comprehensively promoting the robustness of the proposed method against noise interference.

5. Conclusion

This paper proposes a multifeature joint adaptive weighting framework for the design of face image recognition problems. The method uses multiple complementary features to describe the target characteristics, so as to merge their advantages as much as possible. The joint sparse representation is used as the basic classifier to jointly characterize multiple features and use their relevance to improve the accuracy of the representation. For the reconstruction error vectors output by different types of features, a random weight matrix is used for weighted fusion and statistical analysis. Finally, a decision is made based on the statistics of the results under multiple different weights, and a reliable recognition result is obtained. In the experiment, the proposed method is tested based on the public face image data sets. The recognition performance of the method in this paper is better than that of some existing methods for the

original samples and noise samples. The results verify the effectiveness of the proposed method. The method in this paper constructs a framework for multifeature decision fusion, which is suitable for the use of different feature combinations. In the follow-up, the research will conduct in-depth research on the selection of multiple features, give quantitative constraint criteria, and further improve the performance of the recognition method.

Data Availability

The data set can be accessed upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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Retraction

Retracted: Research on Intelligent Scoring and Style of Calligraphy Post Based on Machine Vision

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] Z. Zhigao, Z. Jie, and L. Zhuo, "Research on Intelligent Scoring and Style of Calligraphy Post Based on Machine Vision," *Journal of Sensors*, vol. 2022, Article ID 6398101, 13 pages, 2022.

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Research Article

Research on Intelligent Scoring and Style of Calligraphy Post Based on Machine Vision

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Machine vision is a noncontact measurement method. In some jobs that are not suitable for artificial work environment or artificial vision, machine vision is usually used to replace artificial vision to meet the traditional requirements. Therefore, this paper quotes machine vision into the intelligent scoring and style research of calligraphy post. Firstly, it briefly introduces the related concepts and steps of calligraphy post and briefly explains the style of calligraphy post. Then for the third part of the machine vision localization research algorithm, the correlation function algorithm was proposed in the research field to explain and analyze. Finally, by comparing other research methods of machine vision, it shows that machine vision is more conducive to the study of calligraphy style intelligent scoring, through the experimental study of people on the calligraphy style and calligraphy style of people on the intelligent score. At the end, it is proposed that machine vision can greatly promote the study of intelligent scoring and style of calligraphy and also reflect the accuracy and usability of intelligent scoring for calligraphy style. On-contact test of machine vision refers to not touching the tested object, so as to obtain the test result. It is a three-dimensional testing technology. Among them, the test system of machine vision is relatively simple. It is easy to move and easy to collect data, and the cost of this noncontact test is low. It has more accurate testing technology. A plurality of test quantities can be simultaneously tested by image laser detection of the test quantity without touching the object.

1. Introduction

Machine vision is to study related things from the perspective of neutral and objective technology, and it is also the result of continuous training process that directly depends on technology (understood as the technical surface of inscription). From this point of view, machine vision is always a mature technology. Similarly, in an era of increasing machine learning technology, we can talk not only about machine vision but also about mechanical imagination and mechanical unconsciousness [1]. Machine vision has exploded in recent years. Large-scale, high-quality images and calligraphy impressions greatly support the learning-based machine vision model. However, in the actual situation of limited transmission or storage, images and calligraphy are usually rectified before machine vision analysis, which leads to obvious performance loss of machine vision model. In this work, the paper extensively studies the influence of image and calligraphy on machine vision performance [2]. Machine vision provides a good solution for intelligent score detection of calligraphy posts through appropriate algorithms. With the development of feature extraction technology of calligraphy post, machine vision can effectively score calligraphy post accurately and intelligently, and at the same time, it also reflects the objectivity and accuracy of machine vision method [3]. Combining machine vision method with calligraphy design, it is used for automatic calculation of strain. On this basis, a numerical calculation method based on machine vision is proposed. In this new method, several calligraphy posts are written on the finite element model. It eliminates the limitations of machine vision method, including its sensitivity to vibration, which is the most important advantage of this machine vision model [4]. These related research methods are

combined with machine learning technology in machine vision methods, which deal with colors, shapes, textures, and font sizes from calligraphy. Although there are many applications of different machine learning techniques, due to the wide application of machine learning, this paper introduces the application of statistical machine learning technology and machine vision system in calligraphy scoring. This paper summarizes the application status of machine vision technology in calligraphy imitating system and analyzes the potential of machine vision technology in specific applications [5]. Calligraphy style is considered as the visual attribute of calligraphy character images randomly sampled from "works" created by a single artist. Calligraphy style is independent of page layout or text content. In this paper, an experimental design is designed to study the extent to which the sources of a single or several pairs of character images can be assigned to the same work or two different works. Experiments show that when each pair has many different class pairs, the accuracy is almost the same when using the same characteristics [6]. Calligraphy is an abstract line art, and good calligraphy is vivid. How to have a good calligraphy post, perseverance, clever method, and attention to charm and affection are the most important. It is necessary to grasp the form, spirit, and expression of the author's situation of calligraphy. Only in this way can we write a good calligraphy post and show the high-quality score of calligraphy post style [7]. The artistic style of calligraphy is the best expression of absolute aesthetic concept through the perceptual practice and behavior of the subject of calligraphy. In terms of concept and connotation, the style of calligraphy is not purely material, but different art disciplines and materials disciplines may have an impact on the formation of calligraphy style. Calligraphy post is not an arbitrary behavior of calligraphy subject; it also needs to include the aesthetic concept of the subject. Enjoy the highest pursuit in aesthetic concept, which makes it not only have the universality of the subject but also have the creativity of the subject. Influenced by Chinese classical philosophy, the artistic style of calligraphy post can become an important part of calligraphy post, showing masculine beauty, feminine beauty, and neutral beauty, which is supported by the theory of calligraphy history and calligraphy aesthetic history [8]. In order to improve the effect of calligraphy works, this paper combines intelligent machine learning and reader scoring standard factors to build an intelligent evaluation model and proposes a related algorithm based on machine vision. Finally, it shows that the evaluation model of calligraphy works based on machine vision and intelligent machine evaluation has certain promotion effect on calligraphy post [9]. Intelligent scoring plays a certain role in the study of calligraphy style. In order to study calligraphy style, this paper puts forward the related algorithm of machine vision. The intelligent scoring recognition technology of machine vision is used to score calligraphy posts accurately. And the related machine vision performance algorithm is explained [10]. Intelligent scoring is an indispensable and key part of many evaluation processes, and any development of it can reduce huge potential losses. The evaluation of model performance is different, because different performance measures are adopted for different data sets with different properties in different situations. Therefore, on six real-world intelligent data sets, combined with ten representative performance standards, this study adopts six famous intelligent evaluation classification methods for comprehensive evaluation [11]. In order to study related things, a comprehensive intelligent scoring model is established, which considers various additional variable groups, which increase the accuracy of the model. In order to establish such a model, machine vision technology is proposed as one of the methods of data mining. Finally, it shows that intelligence score has a great positive effect on related research things. It promotes the research of correlation analysis based on machine vision [12]. Style research model is used in most related calligraphy research, and the basic elements of style research model are compared and contrasted. Comparison shows that the study of style is an important issue in artistic aesthetics. Calligraphy is the most aesthetic personality, so art regards the formation of style as a symbol of artistic maturity. As calligraphy is an art, it has its particularity and universality as an art. For calligraphy, style research is the embodiment of his aesthetic personality in the style of his works [13]. Using machine vision and intelligent evaluation in the study of calligraphy style, the purpose is to find out the relationship between calligraphy impressions and related elements. Using machine vision method, 7 items and 25 categories of calligraphy elements are established. In the synthesis step, the relationship between the two elements is studied and quantified. Through regression analysis, some useful parameters are obtained, which are used to explain the reliability of regression and the influence of various categories and elements on calligraphy style research [14]. In the aspect of style research and design, we find that this field is mainly applied to calligraphy-related fields. In the aspect of data analysis and style research, traditional methods are mainly used, and more advanced and novel methods have not yet penetrated into the field of cognitive style. Suggestions and enlightenment are put forward for future research. This is the first review of the practice of cognitive style research methods and represents an important step in the progress of this field [15].

2. Related Concepts of Calligraphy Post and Style Research

2.1. Common Sense of Calligraphy Post. To learn calligraphy, we must start with the works that are posted. This is the only way to learn calligraphy. Pro and Mu are two different methods, each with its own characteristics. The former is the work of famous people with ink shapes or glyph outlines, or the shape is covered on transparent paper with strokes. The ancients said: Linshu is easy to lose the position of the ancients, but there are ancient brushstrokes; Linshu is easy to get the inheritance of the ancients, but most of them are the brushwork of the ancients. Therefore, calligraphy teaching must be combined with copying, learning from each other's strengths, in order to shorten the learning process and achieve the expected results. In addition, scholars must choose exquisite works from the original version (not copies

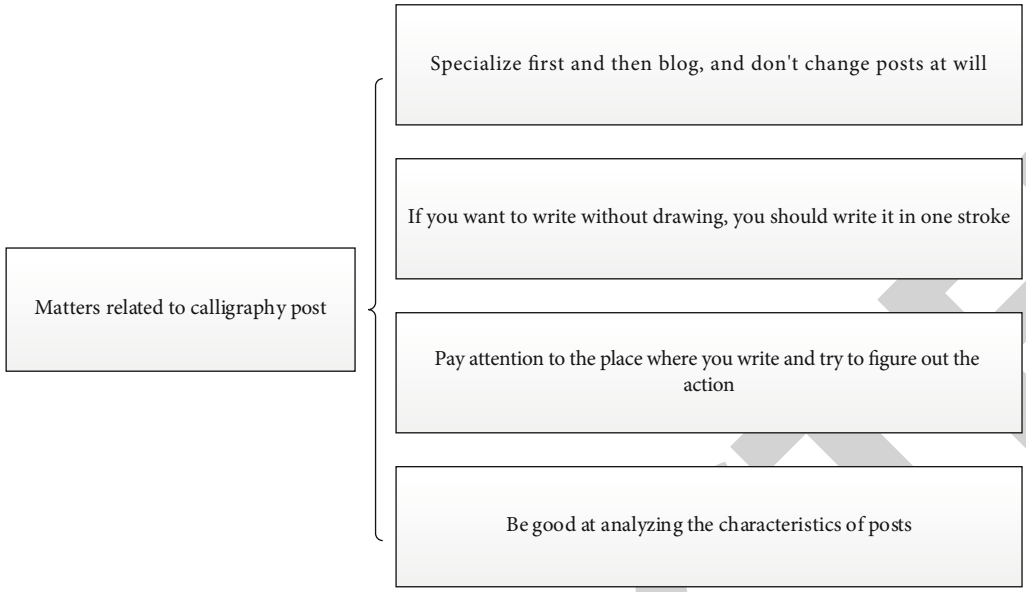

Figure 1: Matters needing attention in calligraphy posting.

of later generations). Then, the basic steps of calligraphy learning and calligraphy creation are reading posts-temporary posts-proofreading posts-silent posts. Reading posts means learning ancient calligraphy and carefully checking what to write. The more carefully you read the post, the stronger the purpose and the better the effect. Beginners tend to ignore this step and use replication instead, especially focusing on results. Generally speaking, "throughout reading" has the following points: pen, character style, chapter, and charm and momentum of the whole article. In addition, for some damaged points in ancient works, pay attention to analysis, find the original state, and do not blindly post at will. Therefore, when posting, the damaged parts are mistakenly used as part of the dot shape, and they are drawn in the same way. Presentation is a long process. After studying all night, you must persevere and write repeatedly in order to get good grades. Proofreading means checking carefully with samples after writing. Through the comparative analysis of calligraphy, find out the shortcomings, and correct the following deficiencies in post writing. Time and time again, I can narrow the gap between myself and the model in this way. Silent post refers to repeated modifications after posting and dictation of fonts in posting. The matters needing attention in the post are shown in Figure 1.

2.2. Methods of Calligraphy Posting. Calligraphy is a bright pearl in the treasure house of Chinese traditional culture and art. Inheriting and continuing this ancient oriental art requires training a large number of successors. Calligraphy teaching is an important way to cultivate learners' aesthetic quality and plays an irreplaceable role in other art disciplines. The priority of learning calligraphy is also a very important step on the road of learning calligraphy. Through temporary posts, we can understand the writing rules of predecessors, Chinese characters and strokes, and their writing methods and structural rules and appreciate the fine traditions of Chinese culture for 5,000 years. As an important part of calligraphy education, the status of calligraphy can affect the level of calligraphy learners. Learning correct methods will greatly improve learners' calligraphy level. We can teach learners to understand the meaning of their calligraphy while writing. When it comes to posting, we must constantly analyze and improve the text and strive to use the text as a legal post. As time goes by, you can develop a good habit of posting. This function has no learning paragraphs and functional structures. We must make progress in this field. When writing a post, find the strokes and good structure, and pay attention to narrowing the gap in the next post. In the long run, the progress will be greater, and the behavior of copying posts will be solved. For example, when a pen is written and then written, the pen has a walking line in the air. For example, when the pen is written and then written, the pen has a circular line in the air, forming the next counter trend. Therefore, we should first read two or three strokes in the process of posting and then write two or three strokes in succession, until we can post a complete word at one time. The problems encountered in the book method are shown in Figure 2.

2.3. The Realm of Calligraphy. In the realm of calligraphy, there are three realms of calligraphy: "eye," "hand," and "heart." The concepts of the last two realms are relatively vague. If there is no clear concept, it will affect the level of future creation. At this stage, the main solution is to improve the observation ability and see the subtleties of posts. Many learners have to be careless, which is basically similar to the original post, but in subtle ways, it is no different from copying. The subtle place of predecessors' calligraphy is often such a stroke by stroke inadvertently, being adept, in order to be slow. In practice, among many calligraphy learners, there are not many people who can completely reach this

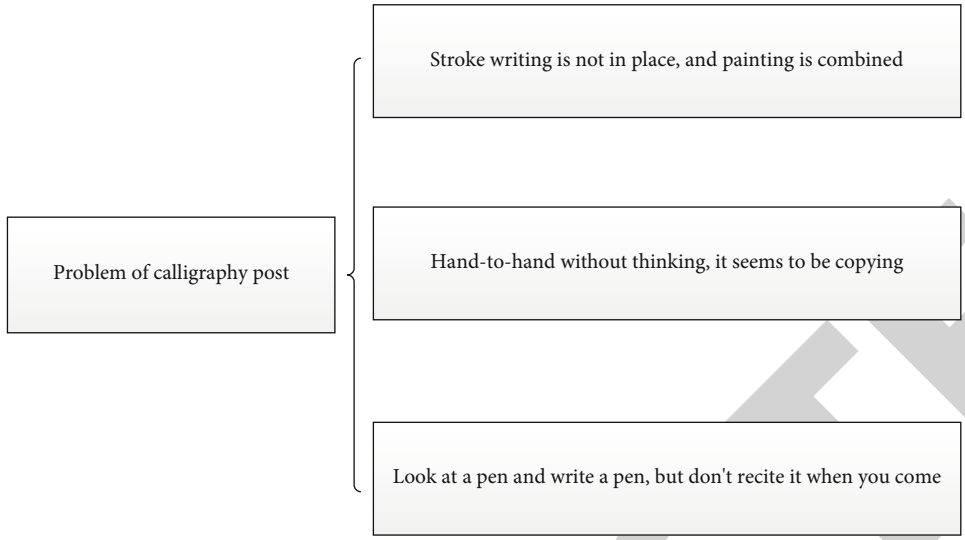

Figure 2: Common problems related to calligraphy posts.

realm. The main reasons are as follows: first, the degree of "eye to brain" could not be reached at the beginning of the study. Secondly, the mentality is impetuous, and Kung Fu is not refined. At present, many scholars are vague about the concept of "those who imitate it are expensive." The meaning of the word "like" is much simpler than imagined. Concept refers to the realm. On the one hand, we should consider the higher requirements for service. On the other hand, when many contemporary calligraphy creators talk about their posters, the articles they say are often more contemporary than the articles. But in their work, it is difficult to see how much essence they absorb. Although this is a calligraphy work, it can be required as the highest standard. However, it is enough to show that technology is not only a skill but also of great cultural significance. That is, when learning the calligraphy tradition of predecessors, we must have technical support, so as to understand it at the spiritual level. The so-called heart-to-heart refers to reaching consistency with the spiritual level of predecessors when posting. Seeing this level means that the pen, structure, and composition of the characters in the French post should be carefully examined, and it is necessary to grasp the stroke form statically and understand the echo relationship between stippling dynamically. Hand to finger is similar in shape, and it is necessary to be similar in spirit. To achieve similar situation, it is natural to write slowly, but to write with an air, it is not skilled and rapid (relatively speaking). Getting to this level is the most basic link in the process of posting. The so-called likeness of form and spirit is just a profound understanding of the external form of pen and ink, although it is very rare to achieve this step. Heart-to-heart refers to the profound spiritual influence on creation and touches the heartstrings of predecessors who stirred their spirits when they waved their brushstrokes.

2.4. Research on the Style of Calligraphy Post. Calligraphy is an art in Chinese calligraphy. It is not only a visual art that can satisfy people visually but also an abstract art, so some people compare calligraphy to a meaningful form. From the perspective of modeling, the ever-changing image is formed through the combination of stippling and painting, which shows people's cognition of various forms of aesthetics such as balance and wandering, coordination and conflict, unity and change, cleanliness and communication, and evacuation and proximity. From the perspective of ideology, the author's emotional connotation and personality culture are expressed by the flow of lines. Since then, stylistic theory has become an important topic in artistic creation and research, which has attracted the attention of western artists and art theorists. Therefore, various good ideas about stylistic have emerged one after another. As calligraphy is an art, it has its own particularity and universality as an art. As for the theory of calligraphy style, it can be said that writers have generally created distinct characteristics and creative personality. It is a relatively stable artistic style formed by writers in calligraphy practice. The unity of the creative subject and his works is a symbol of the maturity of calligraphy and an important standard and scale to measure the success or failure of calligraphy works in art. Specifically, it is the main connotation of calligraphy style theory; first of all, it refers to the nature of calligraphy works. Secondly, it refers to the style of calligraphy. In addition, it also mentions the general characteristics of calligraphy works from content to form, which is the concrete embodiment of calligraphy creation personality in the works. When studying calligraphy style, we should also pay attention to the naming and classification of calligraphy style. Compared with other artistic styles, calligraphy style is usually very good. The determination of the type is helpful to understand and grasp the historical changes of the connotation and extension of the concept of calligraphy style and to describe calligraphy works according to certain style concepts, thus further promoting the diversified development of calligraphy. From a macro point of view, the style of calligraphy art can be divided into two systems: group and individual. As a large system, group calligraphy style refers to the overall style of cluster formed

by more objective factors. As the second category, the individual style of calligraphy art refers to the individual style of calligraphy works. This colorful personalized style is also formed by history, and it also has rich aesthetic connotation, which is the most important factor. Individual style is the foundation of group style, and each individual style has a brand of group style more or less. Group style is composed of different and various personalized styles, which are expressed in personalized style, but it is by no means a simple supplement to personalized style. Calligraphy works with similar thoughts, artistic tendencies, and creative styles form a certain genre. The mutual promotion of the two is conducive to the prosperity and development of calligraphy art creation. Therefore, in the study of calligraphy art creation, we should not only consider calligraphy style and calligraphy genre. From a small point of view, there is a personal style and a special calligraphy style. In the aspect of artistic creation, work style can be said to be the lowest style concept, which refers to different calligraphy styles expressed by specific works created by calligraphy in different time, space, region, and conditions. This style varies widely, but through the comparison, analysis, and research of calligraphy, calligraphy works, and calligraphy works styles, we find that there are similarities and differences among different periods, different regions, and different writers. The calligraphy styles of these groups and individual calligraphy styles are expressed by "works." Today, the desire to form one's own unique style is the pursuit of the life of books. In the long run, this situation is extremely unfavorable to the development and prosperity of calligraphers. The study of calligraphy art must be multiangle and omnidirectional. It is important to pay attention to historical materials, but we cannot do research. Although there are many difficulties in the study of calligraphy style, we cannot avoid this very important problem in calligraphy art because of difficulties. The artistic style of calligraphy is shown in Figure 3: The style of calligraphy is the symbol of the maturity of calligraphy art, and it is the highest realm that calligraphers beg for. A very important historical reason why Chinese calligraphy can be sublimated into an advanced art is that it has reached the ideal realm of aesthetic style, which can compete with the noblest efforts of mankind. Therefore, the study on the style of calligraphy is of great significance to the prosperity of calligraphy art.

3. Correlation Function and Algorithm of Machine Vision

3.1. Location Algorithm of Machine Vision. In the actual positioning of machine vision, sample migration will be cheaper. Therefore, we should use machine vision to detect, so as to avoid the error caused by machine vision in the process of image recognition. It also needs the positioning function of machine vision, which locates the image according to the offset angle of the positioning image, determines the position of the detection area, and makes rotation correction. Therefore, the requirements for positioning features of observable images are quite different. In this paper, two location functions with observed images are given. Rapid image localization based on machine vision is to locate the characters in the target image accurately, and these characters can locate the detected position accurately. In this paper, the correlation coefficient comparison method in machine vision is selected as the matching method in the process of fast positioning and accurate positioning. The fuzzy number set matrix is obtained in the correlation coefficient algorithm of machine vision. The correlation coefficient calculation formula of machine vision positioning is obtained as follows:

$$\rho(x,y) = \frac{\sigma\left(S_{x,y}, g\right)}{\sqrt{D_{x,y} \times D}}, \tag{1}$$

$$D_{x,y} = \frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}\left(S_{x,y}(i,j) - \bar{S}_{x,y}\right)^2. \tag{2}$$

Using machine vision to locate the image to determine the image region to be detected, if the location fails, the phenomenon of using completely different image regions for recognition and detection may appear, which directly affects the quality of subsequent detection results of the algorithm. The machine visual correlation coefficient will not be calculated. Therefore, to calculate the correlation coefficient, it is necessary to locate successfully in the actual detection process of machine vision, and the detection image is captured by industrial cameras in real time. If the machine vision positioning operation takes too much time, it will directly affect the correlation coefficient of the whole detection algorithm and the performance of the real-time detection system. Where D is the variance of G, the formula can be obtained:

$$D = \frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}\left(g(i,j) - \bar{g}\right)^2. \tag{3}$$

When formula (3) and formula (2) are brought into formula (1), the correlation coefficient relationship of machine vision can be obtained as follows:

$$\rho(x,y) = \frac{1/mn\sum_{i=1}^{m}\sum_{j=1}^{n}\left(S_{x,y}(i,j) - \bar{S}_{x,y}\right)\left(g(i,g) - \bar{g}\right)}{\sqrt{1/mn\sum_{i=1}^{m}\sum_{j=1}^{n}\left(S_{x,y}(i,j) - \bar{S}_{x,y}\right)^2 \times \sqrt{1/mn\sum_{i=1}^{m}\sum_{j=1}^{n}\left(g(i,j) - \bar{g}\right)^2}}}. \tag{4}$$

The most important problem of machine vision model matching is how to determine the model image and the matching standard image and match them. Therefore, establishing a good rule matching model in computer vision is the key to improve the matching accuracy. The formula for calculating the sum of square differences is shown in the formula. The commonly used methods for calculating the matching degree of machine vision include square difference matching degree, normalized square difference matching degree, correlation matching degree, normalized correlation matching degree, correlation coefficient matching degree, and normalized correlation coefficient matching degree. The square difference matching degree is calculated by using the sum of squares of the difference between the image and each pixel of the template. In formula (5), the smaller the square

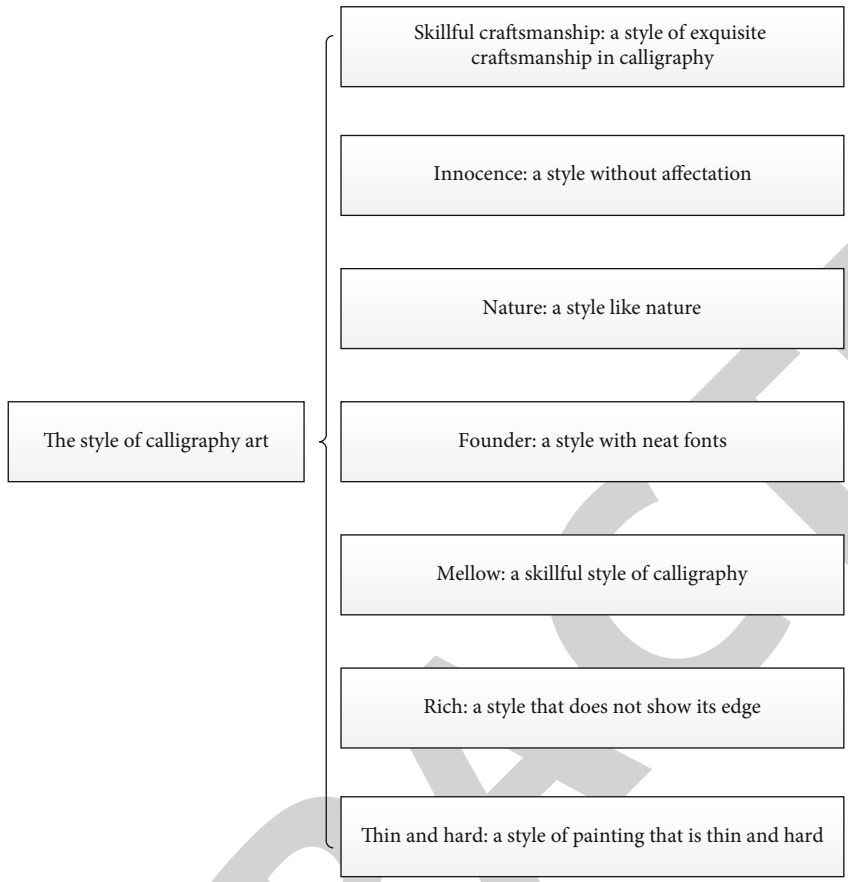

Figure 3: Various related artistic styles of calligraphy post.

difference, the higher the matching degree. Therefore, the accuracy of machine vision positioning is relatively higher.

$$R_{sqdiff} = \sum_{x',y'} \left[T\left(x', y'\right) - I\left(x + x', y + y'\right) \right]^2. \quad (5)$$

In machine vision positioning, I is a projected image, and X and Y are the current distance. The normalized least square method calculates the difference between the equivalent concept and the equivalent square. It also takes advantage of the difference between the machine vision image and the square sum matching of each pixel in the model. Finally, the similarity degree is calculated, and the sum of squares of the original image and gray image is normalized into the machine vision image. The advantage of normalization is that the final matching image has nothing to do with the parameters of the projected image, that is, the machine vision will be blurred when the machine vision model and each pixel of the image are multiplied by the same coefficient. The specific calculation formula is as follows:

$$R_{sqdiff-normed} = \frac{\sum_{x',y'} \left[T\left(x', y'\right) - I\left(x + x', y + y'\right) \right]^2}{\sqrt{\sum_{x',y'} T\left(x', y'\right)^2 \times \sum_{x',y'} I\left(x + x', y + y'\right)^2}}. \quad (6)$$

The higher the similarity and correlation between machine vision image matching and reference pixel, the higher the matching degree in reference model test. 0 represents the worst match result. The specific calculation formula is

$$R_{ccorr} = \sum_{x',y'} T\left(x', y'\right) \times I\left(x + x', y + y'\right). \quad (7)$$

The calculation principle of typical relativistic plane equation is the same as that of equivalence. The similarity is also calculated by the sum of the predicted value of the image and the correlation between different hosts in the model. The result is normalized according to the square sum of gray values of the original image and the image to be measured and calculated by the final equivalent value. The specific calculation formula is

$$R_{corr-normed} = \frac{\sum_{x',y'} T\left(x', y'\right) \times I\left(x + x', y + y'\right)}{\sqrt{\sum_{x',y'} T\left(x', y'\right)^2 \times \sum_{x',y'} I\left(x + x', y + y'\right)^2}}. \quad (8)$$

The specific calculation method of correlation coefficient matching degree of machine vision is the same as correlation matching degree, but the map and model map must be

Table 1: Relative comparison of various visual research methods.

Visual type	Principle	Main technology	Characteristic
Machine vision	Technology combined by optical imaging, artificial intelligence, image processing, and other fields	Feature detection, defect judgment, image detection, etc.	High precision, continuity, high cost efficiency, and flexibility
Computer vision	Through various symbols in data language and computer information mode	Image classification, object detection, target tracking, and so on	Simplified process, fast speed, and automatic processing
Human vision	Light passes through the cornea and through the pupil	Interpret the sensory information according to the knowledge and experience gained in the past	Easy to have illusion and no calculation process

preprocessed before calculating correlation degree. This process reduces the average value of all pixels in the original image and the sample image. The specific calculation formula is

$$R_{ccoeff} = \sum_{x'y'} T'\left(x', y'\right) \times I'\left(x + x', y + y'\right), \tag{9}$$

$$T'\left(x', y'\right) = T\left(x', y'\right) - \frac{\sum_{x',y'} T\left(x', y'\right)}{w \times h}, \tag{10}$$

$$I'\left(x + x', y + y'\right) = I\left(x + x', y + y'\right) - \frac{\sum_{x',y'} I\left(x', y'\right)}{w \times h}. \tag{11}$$

The calculation principle of normalized matching degree of correlation coefficient in machine vision is to calculate the final matching degree of correlation coefficient by comparing the product of square gray value of original image and image to be measured. The obtained results are normalized, and the specific calculation formula is

$$R_{ccoeff-normed} = \frac{\sum_{x',y'} T'\left(x', y'\right) - I'\left(x + x', y + y'\right)}{\sqrt{\sum_{x',y'} T\left(x', y'\right)^2 \sum_{x',y'} I\left(x + x', y + y'\right)^2}}. \tag{12}$$

3.2. Function Algorithm of Machine Vision. Function computation is a very important classification algorithm in the field of machine vision. The existence and necessary and sufficient conditions of structural risk minimization theory lay a foundation for the rapid development of age growth theory. With the development of statistical learning, support vector machine algorithm becomes possible. The basic model of support vector machine is established. By reducing structural risk, the generalization ability of learning is improved, and the empirical risk and confidence interval are reduced. Good statistical rules can be obtained with a small number of statistical samples. For a given machine vision training data set T and hyperplane, the function of machine vision hyperplane with respect to samples is defined as follows: formula (13) is a two-class classification model, and its basic model is defined as the linear classifier with the largest interval in feature space, that is, the learning strategy of support vector machine is the maximum interval, and finally, the related algorithm of machine vision can be transformed into the solution of a convex quadratic programming problem. Therefore, the functional research field of machine vision becomes relatively simple. It is easier to study the training set model and sample template of machine vision.

Table 2: Comparison of scoring time of calligraphy posts by various visuals.

Visual method	Computer vision	Machine vision	Human vision
Feature extraction time, s	0.01302	0.04887	0.05077
Cross-validation time, s	1.82965	0.31708	2.19353
Model comparison time, s	0.00113	0.0002	0.00128
Sorting time, s	0.00099	0.00014	0.00116
Total time spent, s	1.84479	0.36629	2.24674

$$\gamma_i = y_i(w \times x_i + b). \tag{13}$$

Interval function can express the accuracy and influence of prediction. However, it is not enough to choose hyperplane to use intermediate function. This fact reveals that we can add some methods of constraint vector separation on hyperplane, such as normalization, and the interval is deterministic. At present, interval function is introduced into an example of machine vision, and the training method of hyperplane is given. The hyperplane function is calculated as follows:

$$\gamma_i = y_i\left(\frac{w}{|w|} \times x_i + \frac{b}{|w|}\right). \tag{14}$$

In the function calculation of machine vision, compared with most research and analysis, the training set interval of the function is defined as a sample template, and the function calculation formula is

$$\gamma = \min \gamma_i (i = 1, 2, 3, 4 \cdots n). \tag{15}$$

Table 3: Intelligent score of calligraphy post by machine vision.

Level	Level classification	Level requirement	Intelligent scoring
Primary	Level 1	Master the basic writing method of calligraphy post preliminarily, and meet the requirements of correctness and clarity	50-55
	Level 2		55-60
	Level 3		60-65
Intermediate	Level 4	Have a sense of layout, which clearly reflects the characteristics of calligraphy	65-70
	Level 5		70-75
	Level 6		75-80
Advanced	Level 7	Temporary posts achieve unified style and rendering power and use various methods to express calligraphy characteristics	80-85
	Level 8		85-90
	Level 9		90-100

The optimal control plane is determined according to the maximum distance principle. This is a set vector that has a small set that can be used to represent different types of 1 or -1. Linear classifier is to find the machine vision plane. In order to classify all samples correctly and have classification interval, it is required to meet the following requirements:

$$s.t.y_i((w \times x_i) + b) \geq \gamma, i = 1, 2, \cdots, N. \quad (16)$$

The problem of constructing the optimal plane of machine vision is transformed into constraint conditions, and the constraint condition formula expression of the optimal plane of machine vision is

$$\min \psi(w) = \frac{1}{2}\|w\|^2 = \frac{1}{2}\left(w' \times w\right), \quad (17)$$

$$s.t.y((w \cdot x_i) + b) \geq 1, i = 1, \cdots, l. \quad (18)$$

This is a typical convex machine vision optimization problem, also known as constrained optimization problem. The algorithm factor of machine vision can be introduced into this problem, and the optimization relationship of machine vision can be constrained, so that the problem can be transformed into a double problem of machine vision, and the original research can be minimized. The conversion formula is

$$L(w, b, \alpha) = \frac{1}{2}\|w\|^2 - \sum_{i=1}^{i} \alpha(y_i((w \times x_i) + b) - 1). \quad (19)$$

Compared with the algorithm of machine vision, the duality problem is introduced. The so-called machine vision duality is to transform minimax into minimax which is easier to solve, where the expression is

$$\max_{\alpha} \min_{w,b} L(w, b, \alpha). \quad (20)$$

The requirements of machine vision system and the existing structure algorithm cannot meet the detection conditions from the machine vision level, so the original machine vision algorithm is improved. If you encounter linearly indivisible data, it will loop indefinitely until the machine vision correlation coefficient meets the demand. Its functional expression is defined. Formula (21) and formula (22) reflect the research of machine vision into the linear separable functional relation algorithm of support vector machine, which makes the machine vision algorithm more accurate, simpler, and more convenient than direct operation and embodies the high efficiency of machine operation. At the same time, in formula (21) and formula (22), the correlation coefficient of the actual vector machine is calculated by using linear programming bits, and the result is 0, so as to obtain the correlation of the plane model.

$$\min \frac{1}{2}\|w\|^2 + C\sum_{i=1}^{N} \xi_i, \quad (21)$$

$$\nabla_b L(w, b, \xi, a, \mu) = w - \sum_{i=1}^{N} \alpha_i y_i x_i = 0. \quad (22)$$

4. Scoring and Research of Calligraphy Post Based on Machine Vision

4.1. Intelligent Scoring of Calligraphy Post Based on Machine Vision. Machine vision is a widely used research discipline. It works by using cameras instead of faces. Use computers and algorithms to create human brains, instead of using human visual systems to analyze images. The image data is analyzed deeply, the content that the camera needs to be analyzed is expounded, the useful information is obtained from the image analysis, and the final understanding of its application is made, applying machine vision technology to welding, data recognition, fault recognition, positioning equipment, robot vision, and other fields. Therefore, machine vision technology has developed rapidly in different fields. The research of mechanical vision in the fields of intelligent scoring and style research of calligraphy is also widely accepted by people. Therefore, machine vision is superior to computer vision and human vision in the intelligent scoring and style research of calligraphy, because machine vision has high precision and high cost efficiency. The relative comparison between machine vision and other vision is shown in Table 1.

The time spent on feature extraction and cross-validation to find the optimal parameters and the time spent on model comparison and classification recognition are calculated.

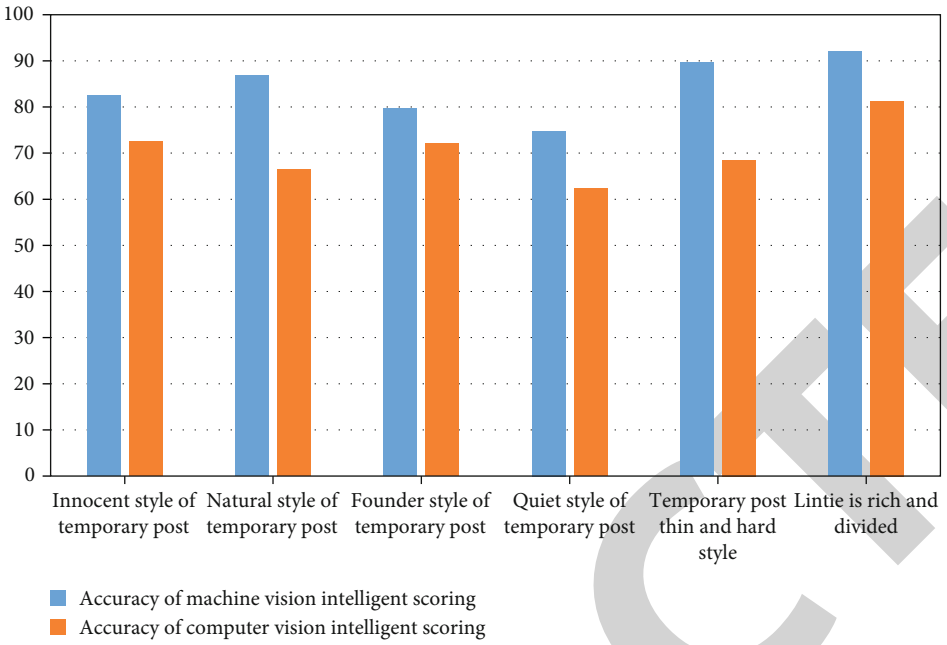

Figure 4: Correct rate of calligraphy style under different intelligent scoring methods.

Specifically, the feature extraction time is calligraphy font feature and the average time of each calligraphy image after feature extraction. Cross-validation time is to calculate a certain number of calligraphy posters. After cross-validation finds the best parameters, the average use time of each calligraphy image was calculated. The time of model comparison is a certain number of calligraphy posters taken from each calligraphy work during model training. Classification and recognition time is the time that each calligraphy image needs a certain number of test samples to classify and recognize calligraphy images. The specific experimental results are shown in Table 2. In machine vision and computer vision, the time of feature extraction in computer vision is longer than that in machine vision, the time of cross-validation is much longer than that in machine vision, and the time of comparison and classification is significantly longer than that in machine vision. Therefore, the research time of computer vision is longer than that of machine vision. This shows that machine vision is superior to computer vision in the extraction of scoring time, and it also shows that machine vision is efficient.

Therefore, we integrate the technology of machine vision into the intelligent scoring of calligraphy posts. Using the relative characteristics of machine vision, such as high precision and flexibility, the intelligent scoring model of calligraphy is established. Through machine vision, nine grades of calligraphy are established, and the first, second, and third grades are divided into primary grades, the fourth, fifth, and sixth grades are divided into intermediate grades, and finally, the seventh, eighth, and ninth grades are divided into advanced grades. Through machine vision, the style of people's calligraphy is rated by machine vision. Make a further study on the calligraphy of modern people. On the basis of machine vision, the style of calligraphy is established for intelligent scoring, as shown in Table 3.

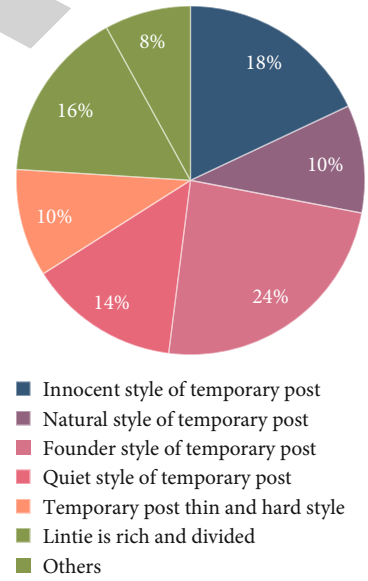

Figure 5: Style types of people's calligraphy posts.

4.2. Research on the Style of Calligraphy Post Based on Machine Vision. Chinese calligraphy can bring people visual satisfaction, but it is also a different artistic expression form and an abstract ideographic art, so some scholars call calligraphy a "meaningful form." From the perspective of modeling, the ever-changing image is formed through the combination of stippling and painting, which shows people's cognition of various forms of aesthetics such as balance and wandering, coordination and conflict, unity and change, cleanliness and communication, and evacuation and proximity. From the perspective of ideology, the author's emotional connotation and personality culture are expressed by

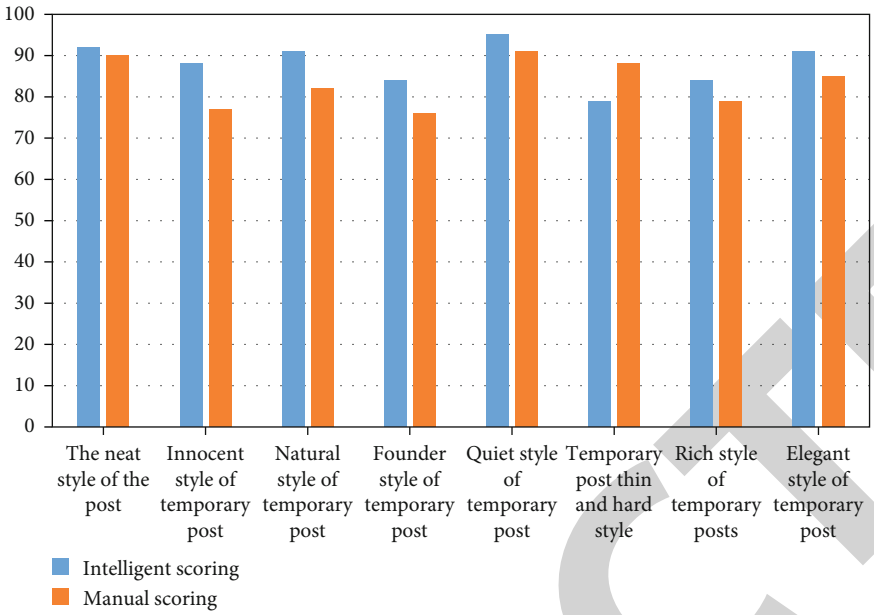

Figure 6: Comparison of the scores of calligraphy style.

the flow of lines. It is pragmatic, and every member of civilized society relies on it to store, transmit, and exchange information. It also has high practicability. Calligraphy is a very common and elegant art in traditional Chinese art, and it is one of the important ways for people to pursue aesthetic ideals and express their will. It is the essence of Chinese artistic spirit. Compared with calligraphers, the style of Lintie is a unique expression of his aesthetic style. Therefore, art regards the formation of style as a symbol of artistic maturity. As calligraphy is an art, it has its own particularity and universality as an art. Therefore, calligraphy has many styles, such as meticulous brushwork, innocence, nature, founder, roundness, and wealth. Here, we draw out several representative calligraphy styles to analyze the correlation of different intelligence scores. The research shows that the accuracy of machine vision is higher than that of computer vision, and it has great advantages in studying the intelligent scoring of calligraphy style. The specific analysis is shown in Figure 4: In Figure 4, machine vision and computer vision are used to score many representative styles of calligraphy, and the accuracy of scoring is compared. Experiments show that in each style of calligraphy, the scoring accuracy of machine vision is greater than that of computer vision. Therefore, in the research, it shows that machine vision has more research value in the style research and intelligent scoring of calligraphy, and the accuracy of intelligent scoring of calligraphy style research by machine vision is relatively higher than that by computer vision.

Calligraphy art aesthetics is a common and popular practical activity. A very important reason why Chinese characters can be sublimated into calligraphy art is that Chinese characters have achieved aesthetic style. Different styles of calligraphy have different ideological characteristics and dynamic art of calligraphy works, and calligraphy has very rich forms of expression. Calligraphy can be divided into group style and individual style. In the individual style, the expression form of calligraphy is vicious, but there is a connection between each one, so people have a variety of calligraphy posts. There are also great differences in people's calligraphy style. Now, this paper investigates people's calligraphy style. A sample of 50 people, including people of all ages and occupations, was selected to ensure the universality of the sample. Detailed investigation of the related styles of calligraphy posts of these 100 people is shown. And use machine vision to intelligently score people's calligraphy posts. Among them, people's calligraphy style is shown in Figure 5, and the intelligent score of people's calligraphy style under machine vision is shown in Figure 6: As can be seen from Figure 5, people's styles of calligraphy are not fixed but vary. It shows that everyone has their own calligraphy style in calligraphy. However, in the scoring system in the calligraphy style in Figure 6, most of the scores of intelligent scores are higher than those of manual scores. There are only one or two styles, and the intelligent score is lower than the manual score, which shows that the intelligent score system is very friendly to people's calligraphy. It has the function of encouraging people to write calligraphy, actively leading people to participate in calligraphy writing, and is conducive to the promotion of people's self-confidence in calligraphy writing.

4.3. Intelligent Scoring of Calligraphy Post Style Research. This study refers to the intelligent scoring of calligraphy beginners' calligraphy posts, so that calligraphy beginners can have a correct understanding of their calligraphy posts. The acquisition of data in the experiment was done, the sample of calligraphy post is the data in the international digital library, and the self-book characters are written by calligraphy beginners according to the post characters. In order to test whether the algorithm of calligraphy post evaluation in this study is basically consistent with the similarity of calligraphy characters judged by people, the experimental

Table 4: Intelligent score of calligraphy post style.

Numbering	Sample	1	2	3	4	5	6	7	8	9	10	Average score
1	Health	64	71	73	77	72	70	66	68	63	71	69.5
2	Books	92	90	82	85	83	86	91	79	85	89	86.2
3	Method	63	68	65	70	66	67	63	62	63	67	65.4
4	I	97	94	99	97	89	92	99	94	89	92	94.2
5	Ground	91	89	85	92	90	89	88	90	92	93	89.9

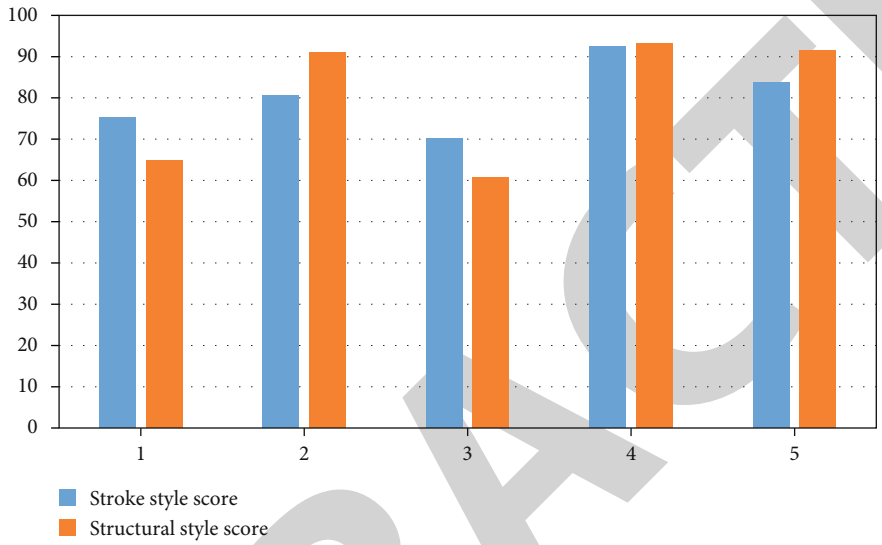

Figure 7: Intelligent score of stroke structure style of calligraphy post.

samples are given to several testers to score their own characters. The testers are students or teachers majoring in calligraphy. Scoring is based on the post characters. Starting from the stroke feature division and structural feature division of calligraphy characters, judge and score whether the self-written characters are "similar" to the post characters, with a full score of 100 points. The evaluation criteria are consistent with the evaluation criteria of this subject. Evaluate whether the self-written characters are "similar" to the post characters from two aspects: stroke division and structure division. Among them, stroke division is mainly evaluated from four characteristics: stroke length, stroke width, stroke starting and closing forms, and stroke trend. Structural division is mainly scored from three aspects: the central position of calligraphy characters, the ratio of height to width of calligraphy characters, and whether self-written characters are correct and straight. A total of 10 testers were investigated this time, and the experimental samples are shown in Table 4.

Comparing the average score of the testers on calligraphy post with the total score of this subject, it is found that the average score of 10 testers on calligraphy post is basically consistent with the total score of this subject according to the evaluation standard of calligraphy post. Experiments show that this study calculates the similarity of calligraphy impressions from multiple characteristic styles of strokes and structures, and the scores of calligraphy impressions are basically in line with human scores. Calligraphy beginners can understand their own learning conditions according to the scores, and this study can be well applied to calligraphy impressions writing guidance. In this study, the similarity of calligraphy posts was evaluated from two aspects, stroke characteristic style and structural characteristic style of calligraphy characters, and summarized and evaluated. The intelligent scoring results are shown in Figure 7.

Under the condition of machine vision, we evaluated the scores of 10 testers by intelligent scoring, in order to study whether the intelligent scoring of machine vision is accurate compared with the scoring of calligraphy style. Firstly, the total scores of 10 testers are calculated by combining the structural scores of calligraphy posts with the stroke style scores of calligraphy posts. The total score is about 70, which has the style characteristics of inclined calligraphy, accurate strokes, loose structure, and general effect. Testers with a total score of 85 have the style that strokes basically follow the requirements of impending posts, the structure is accurate, and the impending posts have good results. The total score of 65 has the style characteristics of accurate strokes and loose structure. The total score is about 92, which has a style with good calligraphy effect, solid strokes, and accurate structure. Testers with a total score of 87 have the style that strokes follow the requirements of the original post, and the structure is accurate, and the post effect is good. Therefore, we will use intelligent scores to estimate the test scores of testers. Compared with the total scores, intelligent scores under machine vision have more accurate prediction data

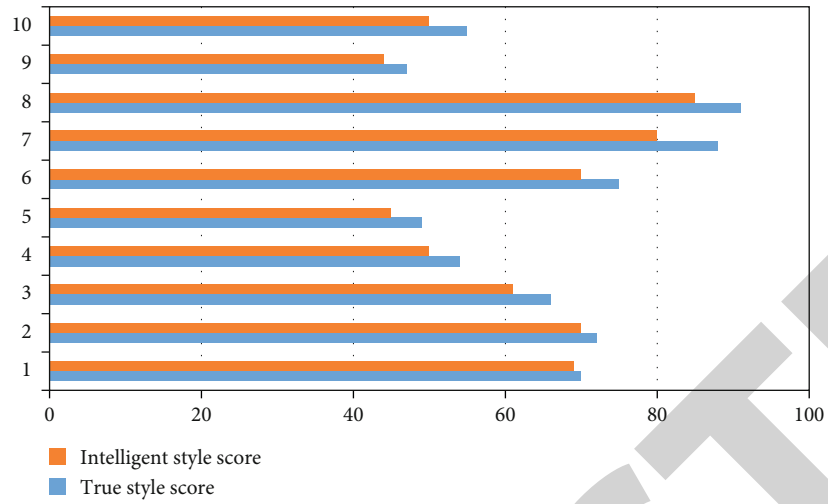

Figure 8: Comparison between real score and intelligent score of calligraphy style.

for the style of calligraphy. Among them, the comparison between the total score of the tester's calligraphy style and the machine vision intelligence score is shown in Figure 8.

It can be seen from Figure 7 that the tester's calligraphy style is associated, and if the stroke style score is not high, the structure style will not be very high. On the contrary, the structural style score with high stroke style score will be relatively higher. It shows that the style of calligraphy is not independent but should complement each other. It can be seen from Figure 8 that there is little difference between the intelligent scores and the actual scores for different styles of calligraphy posts. It shows that the research technology of intelligent scoring can be applied to practical calligraphy research. It is of great reference to the score of calligraphy temporary post research.

5. Concluding Remarks

With the rapid development of machine vision, machine vision technology has been an important part of computer technology since its development. It has existed for more than 20 years. With the development of automation, its functions and application fields have been gradually improved and popularized. In this paper, we use the intelligent scoring of machine vision to score the calligraphy style. At present, with the rapid development of machine vision and intelligence, there are still some shortcomings in calligraphy research. Machine vision has some reference significance for the study of calligraphy style, so it can provide help for calligraphy research in the field of machine vision. It can also help calligraphy learners to have a better understanding of the style of calligraphy post and make calligraphy post have more development in machine vision intelligent scoring. Now is the era of automation. If the calligraphy post evaluation system develops to the intelligent end of machine vision, if it can directly realize the function of evaluating the style of calligraphy post, it will be more convenient for users of calligraphy post and more conducive to studying the style of calligraphy post. In recent years, with the rapid development of intelligent science and technology, machine vision technology, which has the advantages of convenience, accuracy, rapidity, and intelligence, has been widely used in various fields of intelligence. As a modern detection method, it has been paid more and more attention by people. Machine vision technology involves many fields such as computer science, artificial intelligence, signal processing, image processing, machine learning, optics, and automation. Machine vision obtains the image information of the target object through optical equipment and sensors, then converts the image information into digital information, and then displays the data on the electronic screen through computer analysis or guides the machine to complete the task through the control unit. Machine vision focuses on information technology and intelligence, but it is based on the methodology of visual effects of intelligent technology. Its focus is to perceive the position information, size and shape, color information, and existing state of target objects.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

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Retraction

Retracted: Optimization of Color Enhancement Processing for Plane Images Based on Computer Vision

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] Y. Jiao, "Optimization of Color Enhancement Processing for Plane Images Based on Computer Vision," *Journal of Sensors*, vol. 2022, Article ID 3654743, 9 pages, 2022.

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Research Article

Optimization of Color Enhancement Processing for Plane Images Based on Computer Vision

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As the main carrier of information transmission, plane images play an important role in the current network era. In order to enhance the color of the plane image, optimize the image effect, and solve the problem of image distortion with large color difference, a color enhancement processing optimization method is proposed based on the technical support of computer vision. According to computer vision theory, a computer vision model for adjusting perceived color and brightness is constructed. Combining it with the bilateral filtering algorithm, a color enhancement processing optimization model is obtained, which consists of three main stages: illumination information parameter estimation and image color correction, reflection coefficient parameter estimation and image color correction, and adaptive filtering. By estimating illumination information parameters and reflection coefficient parameters, the secondary gamma correction of image color is realized. After being processed by the bilateral filtering algorithm, the final optimized image is obtained. Verified by the subjective and objective evaluation results, the positive correlation index values of this method are all high, 8.0246, 16.4526, 0.9037, and 15.0246, respectively, and the negative correlation index value is low, 49.4169. It is proved that the proposed method can effectively suppress the halo and artifacts and obtain the image color quality that satisfies the visual perception. It not only enhances the image color but also retains the details to the greatest extent.

1. Introduction

A major way for humans to obtain information is through vision [1]. According to relevant statistics, in the process of obtaining information, most of the information is realized by the naked eye [2]. The information carrier seen by the human eye is mainly based on images. As the carrier of information collection, transmission, and storage, it plays an important role in daily production and life [3]. The technology related to digital image processing has been greatly developed, and two ways of application have gradually formed: one is to change the graphic information according to people's visual habits, so as to obtain high-quality visual interpretation, and tt can handle the process of image acquisition, transmission, and storage well [4, 5].

As far as the current digital image processing technology is in many application fields such as archaeology, astronomy, medicine, national defense, biological science, and industry, for machine interpretation, the key to the application of digital image processing technology is how to use reasonable computer processing methods to extract images. Available information is in [6, 7]. Several typical aspects are as follows: automatic identification of language, fingerprints, faces, etc. and military reconnaissance of national defense [8–10]. Therefore, image quality is particularly important, and its pros and cons have a direct impact on the acquisition and effectiveness of image information and determine the satisfaction of human vision needs [11].

Image processing is an effective means to improve image quality and is a classic problem in image research. Image processing techniques are generally divided into binary image processing and color image processing [12, 13]. From the nineteenth century to the middle of the twentieth century, the color of images gradually transitioned from the era of black and white to the era of color, and in the increasing popularity, it developed into the current era of true color and wide color gamut, making human life no longer inseparable from color [14]. The authenticity of color is the main requirement of

image storage and display. When processing color images, it is necessary to focus on solving the problem of color distortion [15, 16]. Therefore, the processing of color images requires a higher level of skill than grayscale images.

Based on the above research background, many scholars have paid close attention to the processing technology of color images and have carried out extensive discussions. For example, in order to make the contrast and color fidelity of the image more balanced, the reference [17] uses the adaptive weight Retinex model to enhance the low frequency band of the image and remove the noise in the high frequency band of the image. The luminance component is reconstructed using inverse wavelet transform. After gamma correction, the enhancement processing of color images is realized. The experimental results verify the balanced effect of the algorithm on contrast and color fidelity. In [18], an enhancement method is proposed for the problem of light attenuation of underwater color images. The red and blue channels are masked by color correction, the contrast is improved according to the color constancy, and the distorted color is restored by adaptive histogram equalization. Image edges and details are processed with fast local Laplacian filters and rolling guided filters, respectively. The results show that this method is superior in enhancing the naturalness of images. Reference [19] generates a color projection image according to the designed nonlinear mapping function and the initial image, instructs the generative adversarial network to learn the inverse function of the nonlinear mapping function, and restores the color projection image. Reference [20] utilizes a progressive collaborative representation framework consisting of offline training and online optimization to remove mosaics from color images. Evaluated on two commonly used test datasets, the framework helps improve image demosaicing performance. Reference [21] uses the K-means method to determine the color set of the image, builds a color image segmentation variational model, and obtains the most suitable color for each pixel. Through the l1 and l2 regularizers, the step effect is overcome, and the segmentation accuracy is improved. The experimental results demonstrate the effectiveness and robustness of the method. By summarizing the above literature methods, it is found that image processing techniques can be roughly divided into denoising, segmentation, enhancement, and other means. Although the existing method can restore the overall color of the image, it still cannot effectively solve the problem of image distortion with severe distortion and large color deviation. Most methods based on image color enhancement apply certain prior knowledge to solve the enhancement problem of flat images, but they often have limitations, such as dust, smoke concentration in the environment, and changes in lighting conditions. Assumptions are challenged, thus affecting the color enhancement of flat images. Evaluation metrics for image enhancement algorithms are a challenging problem. Although there are some indicators for evaluating image quality, the evaluation results of these indicators are far from the perceived quality of the human eye. The index value evaluates a certain aspect of the enhanced image, and the subjective evaluation of the human eye will comprehensively consider various details of the image, such as whether the image is distorted, whether there is a color cast, and whether the occluder is completely removed. Therefore, summing up the scientific evaluation index for the color enhancement problem of plane image is also a difficult point worth studying. In order to facilitate the postprocessing of the image, it is necessary to perform color enhancement on the color image. In particular, the color enhancement of images acquired in special scenes is more realistic. This has important practical implications for many key areas, for example, the images collected by the traffic monitoring system, security monitoring, observation of patient behavior changes in night wards, shooting in modern military reconnaissance, and military intelligent human/vehicle image transmission and other scenarios.

Most of the existing research methods use more traditional algorithms or models. Or use adaptive weight Retinex model and wavelet transform algorithm to process images in frequency bands or use adaptive histogram equalization and Laplace filter to restore distorted colors.

With the development of information technology, computer vision is always in an advanced stage, both in theory and technology, and can meet the needs by processing and analyzing digital images. Therefore, based on the theory of computer vision, this paper constructs a computer vision model according to the relationship between the ambient illumination, the reflected light of the object, and the observed image. Taking this as the basic model structure, a processing optimization model for enhancing the color of plane images is formed by using parameters such as illumination information parameter estimation and image color correction, reflection coefficient parameter estimation and image color correction, and adaptive filtering. In order to increase the color clarity and vividness of the image, the image is more convenient for subsequent analysis and identification operations, and the effectiveness of the image in the fields of monitoring, medical image detection, and military reconnaissance is improved.

2. Construction of an Optimization Model for Image Color Enhancement Processing Based on Computer Vision

2.1. Computer Vision Model. According to computer vision theory [22], a set of adjustment models that can completely describe the human visual system's perception of color and brightness to the naked eye is constructed, as shown in Figure 1. The model reflects why the same object maintains a constant color under different lighting conditions. Whether it is in weak sunlight, strong sunlight, or night light, the perceptual effect of the color feedback of the same object to the human visual system is the same. Since the interaction of light and matter is the decisive factor in human vision's perception of color, the human eye perceives color only directly by the reflection properties of the surface of the object. If the reflectivity of the surface of the object is low, the visually perceived color is darker; otherwise, it is brighter.

The computer vision model divides the image that can be seen by the naked eye into two parts, namely: the illuminance image and the reflection image. The product of the ambient illuminance and the reflected light of the object is the image

Figure 1: Schematic diagram of computer vision model.

pixel point. Therefore, the following expression is used to represent the z image $S(x, y)$ seen by human vision:

$$S(x, y) = L(x, y) * R(x, y)(1). \quad (1)$$

In this formula, L represents the ambient illuminance, covering the illuminance near the object, and R represents the reflected light of the object, which refers to the detailed information of the target, where L is used to describe the slow-changing low-frequency information in the image, and R is used to describe the high-frequency detail information that accounts for a large proportion in the image.

For the changes of illuminance and reflected light, it is generally possible to identify and distinguish the illuminance in the image from the reflection change of the surface of the object by the naked eye and to see the color of the image that changes due to different illuminance. After the brain's reverse deduction, the color constancy of the image is maintained [23]. To sum up, the ambient illuminance L is the main basis for limiting the variation range of the image brightness, and the essential characteristics of the image object are determined according to the reflected light R of the object. Fundamentally speaking, the computer vision model obtains the reflection properties used to express the essence of the target object by removing the ambient illumination in the image, so that the object presents its original appearance.

2.2. Optimization Model for Color Enhancement Processing of Plane Images. Since the computer vision model does not have a good processing effect on images with severe distortion and large color deviation, in order to greatly improve the quality of such flat images, this section combines the computer vision model with the bilateral filtering algorithm to design an adaptive filtering optimization model for planar image color enhancement processing as shown in Figure 2. After three stages of processing: model illumination information parameter estimation and image color correction, reflection coefficient parameter estimation and image color correction, and adaptive filtering, the color of the plane image can be enhanced.

The specific methods of each key component in the model when realizing the color enhancement processing of the plane image are as follows:

(1) Estimation of illumination information parameters and image color correction: use the following two-dimensional zero-mean discrete Gaussian function to estimate the illumination information component:

$$G(x, y) = \frac{1}{2\pi\sigma^2} e^{-x^2+y^2/2\sigma^2} \quad (2)$$

The Gaussian distribution parameter σ in this function plays a decisive role in the width of the Gaussian filter. In the plane image, there is a large correlation between the RGB color space channels, which is easy to cause the image correction deviation based on the reflection coefficient component; so, the HSV color model (i.e., hue (H), saturation (S), and lightness (V)) is used to collect illumination information of images [24, 25]. It is corrected for the V channel (i.e., lightness) in HSV space by gamma correction [26]. After some gray values are integrated together, the fused lighting information has a more ideal brightness. Assuming that the gamma correction coefficient is ∂, the gray value of the image in the color channel after gamma correction is obtained by the following formula:

$$X_{\text{new}} = 255 \times \left(\frac{X}{255}\right)^{1/\partial}. \quad (3)$$

In the above formula, X is the initial gray value of the image in the color channel.

(2) Estimation of reflection coefficient parameters and image color correction: from the perspective of HSV color space, the reflection coefficient parameters of the lightness channel and the hue and saturation channels of the initial image constitute the gray of the image hue, saturation, and lightness channels degree value. From formula (1), the calculation formula of the reflection coefficient $R(x, y)$ of the image in the lightness channel can be deduced, as follows:

$$R(x, y) = \frac{S_i(x, y)}{L(x, y)}. \quad (4)$$

Among them, $S_i(x, y))$ represents the initial image of the luminance channel; $L(x, y)$ represents the image lighting information in this channel.

In the image obtained according to the reflection coefficient, the gray levels of the dark parts and the bright parts show a form of gathering toward the center point. Therefore, when the pixel values of the dark parts increase, the gray levels of the bright parts can be effectively suppressed. Therefore, the following equation is used to correct the image grayscale to prevent the occurrence of false halo and obtain the image grayscale value after gamma correction [27]:

$$X_{\text{new}} = 255 \times \left(\frac{X}{255}\right)^{1/g} \quad (5)$$

In this formula, X is the initial gray value of the reflection coefficient image, X_{new} refers to the gray value of the image after gamma correction, and "G" refers to the gamma coefficient [28].

(3) Adaptive filtering: when correcting flat images, it is inevitable to increase the noise of different degrees [29]. After using the computer vision model to

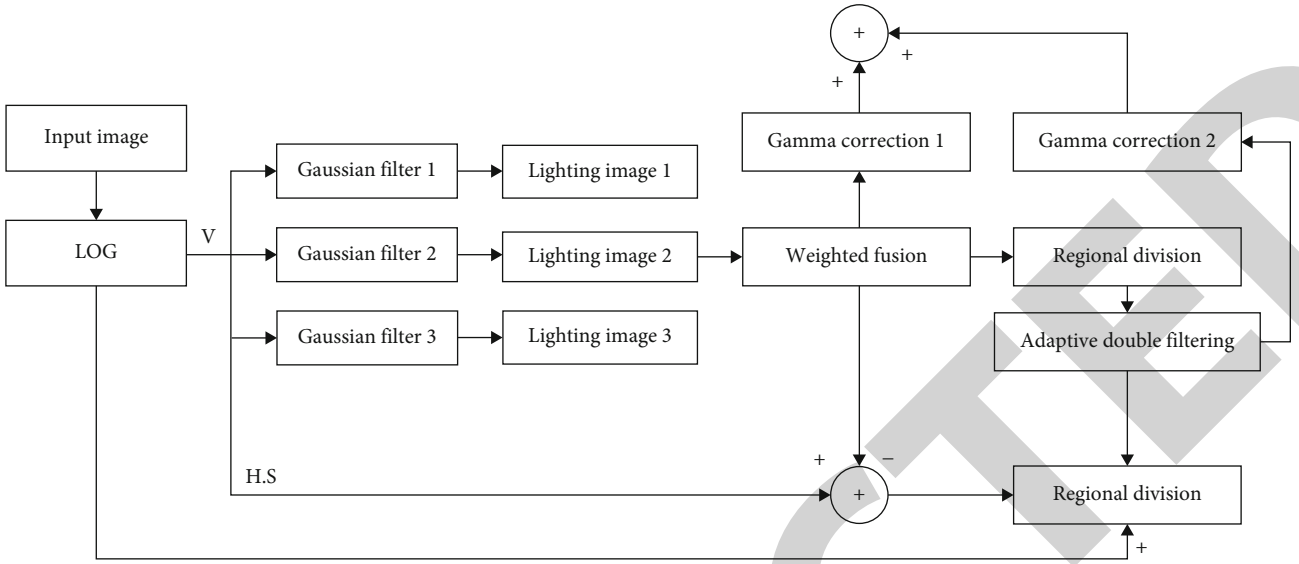

Figure 2: Schematic diagram of the optimization model for color enhancement processing of plane images.

process the flat image, even if the noise amplitude in the dark part does not change much, it will be highlighted and reduce the image quality. Therefore, based on the bilateral filtering algorithm, a noise reduction and enhancement processing method suitable for reflection coefficient images is constructed. By processing different brightness areas in the image in a targeted manner, most of the image details and texture information can be retained as high as possible [30]. The implementation process of the proposed method is shown in Figure 3

The adaptive filter color enhancement method of bilateral filtering has a smoothing and denoising function similar to other algorithms. However, by using a certain weighted average of adjacent pixel values, the new method introduces two different forms of weight consideration factors, that is, the similarity between pixel values and the spatial distance relationship between adjacent pixels, which greatly preserves the texture details of the image. A transition area is added between the bright area and the dark area, and the method uses mesoscale bilateral filtering for the transition brightness area. For the dark area, bright area, and transition area of the reflection coefficient image R, large-scale, small-scale, and medium-scale bilateral filters are used for filtering, respectively. Ultimately, the filtering effect of the entire image is more natural.

3. Enhanced Processing Optimization Model Performance Detection Experiment

3.1. Experiment Preparation Stage. From the commonly used image database, 100 plane images of the same specification with large depth of field, containing a lot of details and color information, and colors with different degrees of distortion were randomly selected as detection samples to verify the generalization ability and color enhancement ability of the model. In order to improve the persuasiveness of the image evaluation results and the reliability of the data, an evaluation method combining subjective and objective is adopted to comprehensively evaluate the enhanced processing ability of the model for image color. Among them, the subjective evaluation method generally makes judgments based on the visual perception of the naked eye. This method is simple and intuitive and can quickly complete the evaluation; the objective evaluation method generally extracts the statistical value of the image and uses numbers for quantitative analysis. Since only one indicator cannot accurately describe the output image effect, the following objective evaluation indicators are selected to make a more comprehensive and accurate judgment on the optimization results of color enhancement processing of flat images from various aspects:

(1) Information entropy: this indicator reflects the amount of information contained in the image. The larger the information entropy value, the more information it contains, and the higher the image quality. It can be solved by the following calculation formula:

$$E = -\sum_{i=0}^{n} P_{(i)} \log_2 P_{(i)}. \tag{6}$$

In the above formula, n refers to the gray value range, and $P_{(i)}(i = 1, 2, \cdots\cdots n)$ refers to the information contained in each pixel in the image.

(2) Average gradient: this indicator is used to express the degree of change of image pixels. By averaging the gradient values of each pixel, it can be known, as

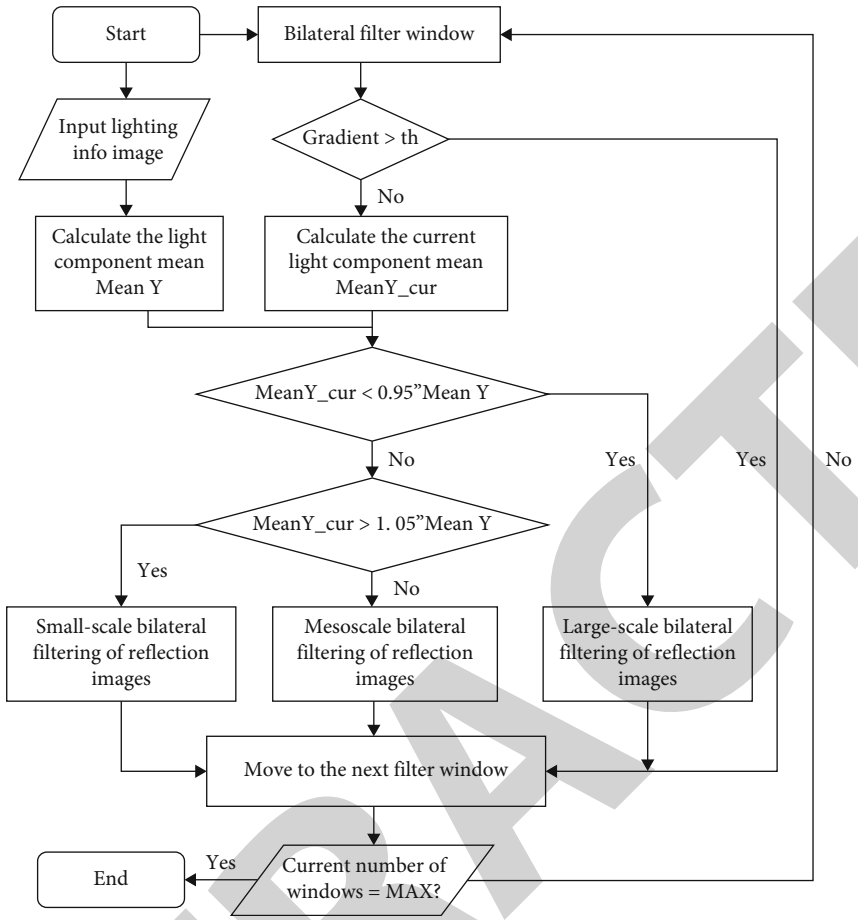

Figure 3: Flow chart of adaptive filtering color enhancement based on bilateral filtering.

shown in the following expression. The larger the index value, the clearer the image

$$\bar{G} = \frac{1}{m \times n} \sum_{i=1}^{M} \sum_{j=1}^{n} \left(\left(\frac{\partial f_{i,j}}{\partial x_i} \right)^2 + \left(\frac{\partial f_{i,j}}{\partial y_j} \right)^2 / 2 \right)^{1/2}. \quad (7)$$

In the formula, m and n are the width and height of the plan image, respectively, and $f_{i,j}$ refers to the gray value of the pixel point (i, j).

(3) Standard deviation: this indicator is the dispersion of the image relative to the mean. The larger the value, the more dispersed the image. According to statistical knowledge, the standard deviation of the image is obtained by the following formula:

$$\sigma = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (x_i - \mu)^2}. \quad (8)$$

(4) Peak signal-to-noise ratio: this indicator is further defined based on the mean square error indicator. The defining formula is as follows:

$$\mathrm{PSNR} = 10 * \log \left(\frac{\mathrm{MAX}_I^2}{\mathrm{MSE}} \right). \quad (9)$$

In the above formula, MSE is the mean square error, and MAX_1 is the maximum chroma of the image, which is 255.

According to the formula structure, it can be seen that the value of the peak signal-to-noise ratio is inversely proportional to the mean square error value. That is to say, the smaller the pixel difference between the target image and the reference image, the smaller the mean square error value, the larger the value of the peak signal-to-noise ratio, and the better the effect of image color enhancement processing.

(5) Structural similarity: the similarity is judged by comparing the structure, brightness component, and contrast component of two images. When the two images are identical, the structural similarity value is 1. The fewer similarities between the optimized image and the reference image, and the smaller the structural similarity value, the worse the output image effect is. If the value of the structural similarity value is larger, the structural similarity of the image is higher, and the processing effect is better. The evaluation result of this indicator is calculated using the following mathematical formula:

$$\mathrm{SSIM}(x, y) = \frac{\left(2\mu_x\mu_y + C_1\right)\left(2\sigma_{xy} + C_2\right)}{\left(\mu_x^2 + \mu_y^2 + C_1\right)\left(\sigma_x^2 + \sigma_y^2 + C_2\right)}. \quad (10)$$

In this formula, μ_x and μ_y represent the mean of the processed and optimized image and the reference image, respectively, σ_x and σ_y are the corresponding variances of the two images, and $\sigma_{xy} + C/\sigma_x\sigma_y + C$ are the structural components of the two images.

4. Results and Analysis

4.1. Analysis of Subjective Evaluation Results. The purpose of this paper is to enhance the color of flat images through processing optimization. Regarding the image quality evaluation method, it can better evaluate the quality of image processing, and it has also become an indispensable auxiliary scheme in the research and development of digital image processing technology. Generally, image quality evaluation is divided into subjective evaluation and objective evaluation. Among them, the subjective evaluation method generally makes judgments based on the visual perception of the naked eye. This method is simple and intuitive and can quickly complete the evaluation. The objective evaluation method is generally to extract the statistical value of the image and perform quantitative analysis with numbers. Combining the subjective evaluation method and the objective evaluation method, the image quality and the processing performance of the method can basically be accurately evaluated.

A sample image is arbitrarily selected from the selected 100 images as the operation object of different image processing methods. Using the two methods based on adaptive weight Retinex model and adaptive histogram mentioned in the literature method (i.e., literature [17] and literature [18]) and the method in this paper, the image is enhanced to verify this paper: the superiority of the method. After the target image is processed by different color enhancement methods, the color enhancement processing optimization result of the sample image is obtained.

By comparing the color enhancement effects of plane images processed by each method, it can be seen that all three methods have certain enhancement and optimization effects on the color of plane images, but the degree is different. Although the reference [17] achieved color enhancement for the sample image, it caused color distortion in the sky area, resulting in color deviation and obvious halo and artifacts. The greater the depth of field, the more halo and artifacts. Obviously, the information loss is also serious, especially at the junction of color conversion, the degree is even worse, and the visual effect is poor. Reference [18] has slightly improved; although, the halo and artifacts are reduced to a certain extent, but the details in the image are still not revealed, the enhanced image has the problem of overexposure, and it is not well demonstrated in the image color quality that can satisfy the visual perception of the human eye. To sum up, the contrast methods are not good for the color enhancement processing of flat images. By summarizing the above literature methods, it is found that image processing techniques can be roughly divided into denoising, segmentation, enhancement, and other means. Although the existing method can restore the overall color of the image, it still cannot effectively solve the problem of image distortion with severe distortion and large color deviation.

In this paper, the HSV color model (i.e., hue (H), saturation (S), and lightness (V)) is used to collect the illumination information of the image. It is corrected by the V channel (i.e., lightness) in HSV space by gamma correction. After some gray values are integrated together, the fused lighting information has a more ideal brightness. According to the image obtained by the reflection coefficient, the grayscale of the image is corrected by the gamma correction method, which effectively prevents the occurrence of false halo. Based on the bilateral filtering algorithm, the noise in the reflection coefficient image is suppressed to a great extent. Therefore, it not only enhances the overall color of the plane image but also obtains a color enhancement effect that is significantly better than the contrast method on the premise of maintaining the detail information to a great extent and effectively suppresses halo and artifacts. Even when the depth of field of the image is large, high-level enhancement processing results are still obtained. Whether it is the color information of trees or the detailed information of roads and plants, they can be well enhanced and completely preserved. The texture and details are very close to the real situation, which greatly optimizes the visual experience of the human eye. Most of the existing research methods use more traditional algorithms or models, use adaptive weight Retinex model and wavelet transform algorithm to process images in frequency bands, or use adaptive histogram equalization and Laplace filter to restore distorted colors.

4.2. Analysis of Objective Evaluation Results. The subjective judgment method is usually affected by the evaluators themselves. Therefore, the objective evaluation method based on mathematical statistics is adopted, and the evaluation method can optimize the color enhancement processing ability of the plane image. After calculation, the evaluation index data corresponding to the three methods are obtained, as shown in Figure 4.

According to the quantitative evaluation results of the enhancement ability of different methods in processing 100 sample images in Figure 4, it can be seen that the information entropy, standard deviation, average gradient, structural similarity, and peak signal-to-noise ratio of the literature [17] are 7.5137, 59.2867, 9.1673, 0.4567, and 10.0897, respectively. The information entropy, standard deviation, average gradient, structural similarity, and peak signal-to-noise ratio of the literature [18] are 7.7743, 67.7835, 12.3749, 0.6214, and 10.8967, respectively. The information entropy, standard deviation, average gradient, structural similarity, and peak signal-to-noise ratio of the method in this paper are 8.0246, 49.4169, 16.4526, 0.9037, and 15.0246, respectively. The obtained experimental data is sufficient to prove that, compared with the two comparison methods, the values of the positive correlation indicators of the method in this paper are all higher (i.e., 8.0246,

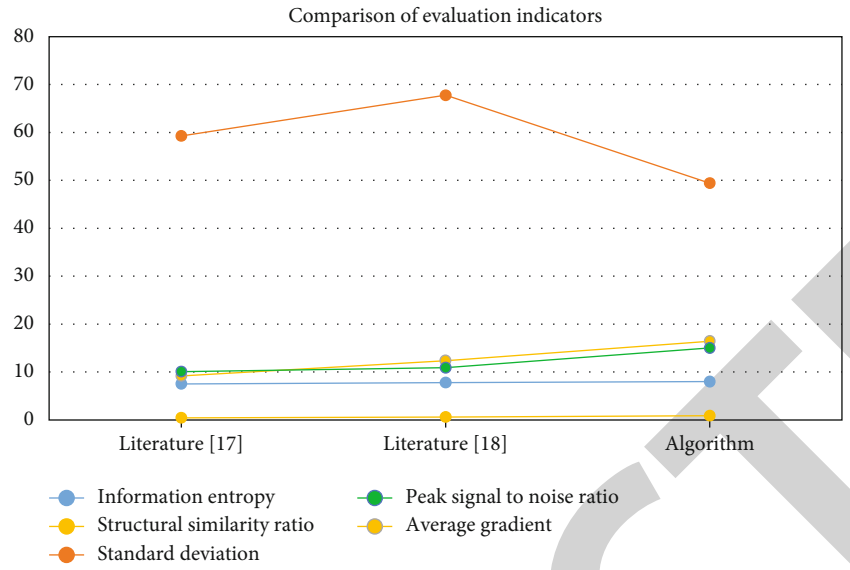

Figure 4: Schematic diagram of objective evaluation index values for different methods.

16.4526, 0.9037, and 15.0246), and the standard deviation of the negative correlation is lower (i.e., 49.4169). It shows that the method can effectively enhance the color of the plane image, also shows excellent performance in preserving the details of the image, and has greater universality. Because this paper integrates the computer vision model and bilateral filtering algorithm, according to the estimated illumination information parameters and reflection coefficient parameters, using the gamma correction method, the color of the plane image is corrected twice in the brightness channel in the HSV space, respectively. Make the fused lighting information that have more ideal brightness. While suppressing the gray level of the bright part, the noise contained in the reflectance image is reduced. By specifically processing different brightness areas in the image, most of the image detail texture information is preserved as high as possible. Therefore, it not only avoids the defect of loss of detail information generated in the process of enhancement processing and optimization but also makes the plane image carry more high-definition information. Moreover, the color of the image is greatly improved, and the halo phenomenon and color distortion are effectively prevented, so that the enhanced image is closer to the real clear image. The above indicators further illustrate that the planar image processed and optimized by the method in this paper is more in line with the human visual perception. At the same time, the method in this paper also has ideal generalization and adaptability. If only one of the indicators is used, it cannot accurately describe the output image effect. Therefore, five objective evaluation indicators are selected: information entropy, standard deviation, average gradient, structural similarity, and peak signal-to-noise ratio. The five evaluation metrics describe different aspects and angles of the image. For example, information entropy reflects the amount of information contained in an image. The average gradient reflects the degree of change in image pixels. The standard deviation reflects the dispersion of the image relative to the mean. The peak signal-to-noise ratio is further defined based on the mean square error index, which reflects the evaluation value of the difference between the pixel value of the image to be evaluated and the standard reference image. Structural similarity is a similarity judgment based on the comparison of the structure, brightness components, and contrast components of two images. After synthesizing the objective evaluation results of the five indicators, it is enough to accurately determine the difference between the color enhancement processing optimization results of the plane image and each model.

5. Discussion

As the most important link in image processing, image enhancement is in an urgent development stage as people's requirements for image quality continue to increase. Although the enhancement processing optimization method proposed in this paper has significant advantages in color enhancement and detail preservation, this method is more suitable for color processing of flat images, and the current image types have already been upgraded from flat images to stereo images. Therefore, it is still necessary to carry out further optimization from the following directions in the future to expand the application scope and prospects of the method.

(1) With the rapid development of computer technology, a large number of high-tech science and technology and innovative algorithms and models have emerged. More advanced techniques should be tried for better processing optimization

(2) There are various types of images, and the next research focus will be on different types of images to develop a processing optimization method that also has better performance for other types of images

The innovation of this paper is to combine the computer vision model with the bilateral filtering algorithm to design

an adaptive filtering optimization model for color enhancement of planar images. The model first uses a two-dimensional zero-mean discrete Gaussian function to estimate the illumination information component. It is corrected by the V channel (i.e., lightness) in HSV space by gamma correction. Then, according to the computer vision model, the reflection coefficient of the image in the lightness channel is derived. The gamma correction method is used to correct the grayscale of the image to prevent the occurrence of false halo. Referring to the bilateral filtering algorithm, the different brightness areas in the image are processed by targeted noise reduction, the subjective and objective evaluation results are verified as high as possible at 15.0246, and the negative correlation index value is lower at 49.4169. It is proved that the proposed method can effectively suppress the phenomenon of halo and artifacts and obtain the image color quality that satisfies the visual perception. It not only enhances the image color but also retains the detail information to the greatest extent. The data listed by the author can well support the point of view and are worthy of publication, but there are still several issues that need to be confirmed.

6. Conclusion

As a kind of information carrier in the current network age, image has huge use value. The computer vision technology derived from the human eye model has been widely used in modern life and work through gradual development, among which image processing is the most common. Therefore, this paper builds a model based on computer vision theory for the color problem of flat images and obtains a processing optimization model for enhancing image color by combining computer vision model and bilateral filtering algorithm. After subjective and objective evaluation, the following three conclusions are drawn:

(1) Different methods have a certain enhancement and optimization effect on the color of the plane image, but the degree is different. In this paper, the color of the image is corrected twice, and the processing optimization effect is the best

(2) Using the HSV color model and gamma correction method, combined with the estimated illumination information and reflection coefficient, the pseudo-halo phenomenon is effectively prevented. The average gradient and structural similarity of the image are 16.4526 and 0.9037 higher than those of the contrast method

(3) The noise in the reflection coefficient image is effectively suppressed by the bilateral filtering algorithm. Among the three methods, the highest peak signal-to-noise ratio value was obtained, namely, 15.0246

Although the enhancement processing optimization method proposed in this study has significant advantages in color enhancement and detail preservation, this method is more suitable for color processing of flat images, and the current image types have already been upgraded from flat images to stereoscopic images. Therefore, it is still necessary to carry out further optimization from the following directions in the future to expand the application scope and prospects of the method. More advanced techniques should be tried for better processing optimization. The next research focus will be to develop a processing optimization method that can perform well for other types of images for different types of images.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares no conflicts of interest regarding this work.

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Research Article

Research and Application of Business Law Information Management System Based on Big Data

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China's manufacturing industry has set off a wave of digital transformation innovation, and the commercial law information management system, as one of the important tools to enhance the intelligent management ability of enterprises, will also face a new round of reform and upgrade. Building an "intelligent commercial law information management system platform" is the primary transformation path for traditional manufacturing enterprises to realize intelligent upgrading of commercial law information management system. The "intelligent commercial law information management system platform" is a management information sharing service platform that enables enterprises to achieve the goal of collaborative management by integrating their own business models and product technology needs with the help of emerging digital technologies, which can help enterprises realize the organic integration of business processes, risk management, value creation, and other management needs and change the original. The platform can help enterprises realize the organic integration of business processes, risk management, value creation, and other management needs and change the focus of the traditional financial shared service center, so that the enterprise business law information management system can be shifted to the enterprise strategy-oriented, focusing on risk control, decision support, and other high-level management. Therefore, it is particularly important to evaluate and optimize the "intelligent business law information management system platform" of manufacturing enterprises in the process of digital transformation. In this context, this paper conducts research and application of commercial law information management system based on big data, conducts an in-depth study on the current status of commercial law information management system in China, and provides an outlook on commercial law information management in China by establishing a relevant model system.

1. Introduction

In recent years, China's manufacturing industry has embarked on a digital transformation innovation boom, and the commercial law information management system, as one of the important tools to enhance the intelligent management ability of enterprises, will also face a new round of reform and upgrade. Building an "intelligent commercial law information management system platform" is the primary transformation path for traditional manufacturing enterprises to realize intelligent upgrading of commercial law information management system [1]. The "intelligent commercial law information management system platform" is a management information sharing service platform that enables enterprises to achieve the goal of collaborative management by integrating their own business models and product technology needs with the help of emerging digital technologies, which can help enterprises realize the organic integration of business processes, risk management, value creation, and other management needs and change the original. This platform can help enterprises realize the organic integration of business processes, risk management, value creation, and other management needs and change the focus of the traditional financial shared service center, so that the enterprise business law information management system can be shifted to the enterprise strategy-oriented, focusing on risk control, decision support, and other high-level management work [2]. Therefore, it is particularly important to evaluate and optimize the "intelligent business law information management system platform" for manufacturing enterprises in digital transformation.

Currently, the digital economy is still the main driver of high-quality economic growth in China, so the digital transformation of traditional production industries is the trend, state-owned enterprises (SOEs) play a leading role in the wave of technological and industrial transformation, and their digital transformation can lead the rapid transformation of China's enterprises and further strengthen their own strength, thus gradually becoming the focus of this wave of economic change [3]. In August 2020, the State-owned Assets Supervision and Administration Commission of the State Council issued a document on accelerating the digital transformation management of SOEs, in which it was clearly pointed out that SOEs should strengthen the infrastructure of pillar capabilities, form a digital transformation mechanism and be supervised by the enterprise management, and establish a systematic management assessment system from multiple perspectives, such as business and management, to evaluate the transformation effect in stages and achieve a continuous improvement with each iteration. The effect of continuous improvement is achieved iteration by iteration [4]. The "intelligent business law information management system" brings new changes in internal reporting, early warning and prediction, analysis, and decision making with the integration of "data + management." In the process of redefining and improving the management model of enterprises through digital transformation, data resources need to be unlocked to their corresponding value, and it is not enough to rely on digital technology alone, which requires "intelligent commercial law information management system" to become a more powerful support base [5]. The current situation of the input of commercial law information management system in China is shown in Figure 1.

At the same time, China faced a major impact of the new pneumonia in 2020, and the relevant departments of the country indicated that they should make up for the problems and weaknesses of the relevant industries exposed during the prevention and control of the epidemic as soon as possible, vigorously develop the new industries and new models that emerged during the prevention and control of the epidemic, promote the development of the industrial Internet, promote the coordinated development of various industries, give birth to more new industrial models, give full play to the foundation and support of the new digital infrastructure, and improve the risk warning and information management system. Support role, improve risk warning and control ability, and then promote the digital transformation of manufacturing industry [6]. Based on this, a systematic all-round assessment of enterprises in the process of digital transformation of state-owned enterprises can clarify the digital stage and the internal and external challenges faced by the transforming enterprises, so as to subsequently develop a more reasonable digital transformation plan [7].

2. Research Background

With the increase of labor and production costs, manufacturing enterprises are facing problems related to the overall increase of operating costs, and some of them have difficulties in maintaining their competitiveness in the era of big data; therefore, it is a natural step for manufacturing enterprises to implement digital transformation and make digital transformation as a new strategic model for enterprises [8]. The digital transformation of a company is to innovate the business operation model with the purpose of shaping the digital enterprise integration management by integrating manufacturing and financial management with the help of digital technology. According to the business characteristics of manufacturing companies, the company should enhance its development capabilities, integrate digital technologies, reconfigure corporate strategies, and promote internal reforms in order to promote the digital transformation of the company [9].

The digital transformation of enterprises should improve the performance of enterprises through intelligent technology and through the use of digital technology, which in turn helps enterprises to eliminate data silos between various departments in their industries and upstream and downstream enterprises in the supply chain, improve the overall production and operational efficiency of enterprises, and, in this way, build a new technological enterprise ecological model for enterprises [10]. However, there are relevant theories that digital transformation is the direction of thinking for the whole enterprise, that is, the enterprise uses digital technology to transform the operation of each sector of the enterprise by reconstructing the value proposition of upstream and downstream customers and then urges the value creation of traditional manufacturing enterprises and the rearrangement of business models after transformation to ensure that the enterprise can sustain its core competitiveness in the industry in the digital economic system; in addition, there are scholars who believe that putting digital transformation is a strategic transformation of the company [11]. There are also theories that for a company to be successful in digital transformation, in addition to relying on advanced digital technologies, it is important to consider the adaptation of digital technologies in all sectors of the company: digital technologies are a means, not the ultimate goal of digital transformation. Some foreign scholars have analyzed the factors influencing corporate transformation from an empirical point of view, pointing out that web technologies and cloud computing have improved the business performance of companies to a certain extent, thus contributing to their transformation [12]. The key to successful corporate digital transformation lies in the integration of internal and external resources and the effective management of internal and external capabilities, while external capabilities are the key to achieving digital transformation [13].

In terms of the opportunity for digital transformation of enterprises, the study found that South African banks adopted digital transformation based on government regulation, i.e., South African banks were required to conduct regular reviews of customers in response to government demand, and thus, tedious and repetitive tasks prompted them to undergo digital transformation. Digital transformation by companies is driven by customer needs and digital technology [14]. Some scholars have described the opportunities for digital transformation of enterprises across systems based on the difference between digitalization and industrialization in two ways: first, the nature of enterprise resources

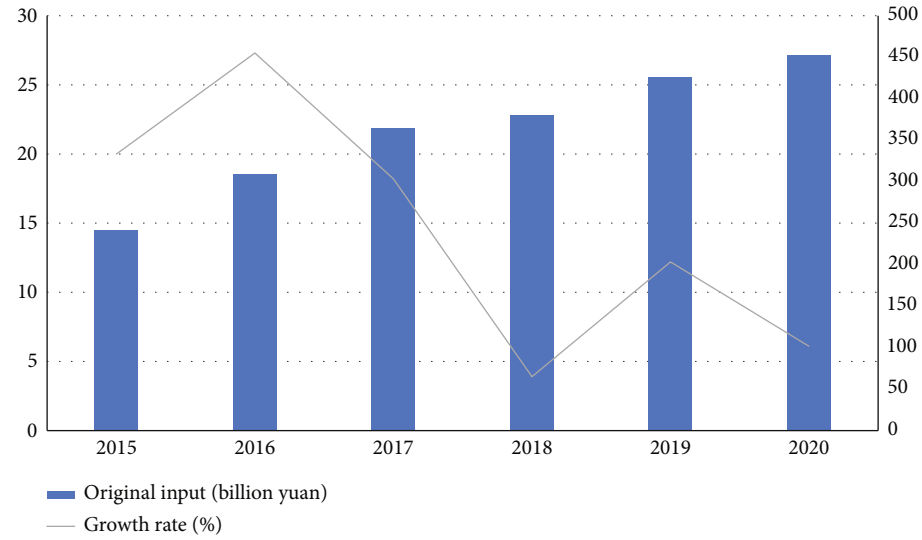

Figure 1: Current situation of investment in China's commercial law information management system.

and information architecture has changed essentially; second, enterprise management has undergone adaptive changes. Some theories, based on the development trend of the new generation of information technology, conclude that companies face social pressures based on high payroll labor costs, which promote the rapid development of artificial intelligence technologies, thus creating a domino effect and accelerating the digital transformation of companies [15]. It has been found that manufacturing companies undergoing digital transformation have a cohort effect and are highly influenced by companies in the same industry and prone to imitation learning. For the study of enterprise digital transformation paths, some scholars, from three aspects of capacity, path, and direction of China's manufacturing enterprises, face the digital transformation dilemma, and according to the transformation dilemma faced by the manufacturing industry from improving dynamic capabilities, integration of traditional and emerging business, synergistic multisubject environment, and open sharing four aspects of the transformation path. Some foreign theories believe that digital transformation of enterprises is the transformation of business model from product to service, which affects the value acquisition and innovation mode of enterprises and makes them reap efficient operation efficiency and performance management under the new business model of "product + service." A scholar in Beijing believes that in the new era of digitalization, enterprise management has transformed from enabling to enabling, so he tries to build a digital enterprise operation theory and improve the path of efficient operation of enterprises. Based on three central enterprises that have successfully achieved digital transformation, a scholar in Jiangsu attempts to build a digital transformation strategy targeting state-owned enterprises, so as to choose the path of digital transformation for enterprises. A scholar in Dalian believes that most of China's military enterprises have not realized digitalization, and only a few are in networked management, so it is believed that their digital transformation mainly includes (1) implementing intelligent management, integrated management, and analysis of the enterprise's operation data to help the implementation of business decisions; (2) applying intelligent manufacturing in the whole production process to achieve upstream and downstream collaboration; and (3) establishing refined digital design and simulation research system to improve product configuration, production management. The current status of the construction of intelligent commercial law information management system in China's enterprises, measured by relevant indicators, is compared with foreign countries, as shown in Figure 2.

In addition, this paper also explores the demand for intelligent commercial law information management system platform for enterprises, which includes the following four indicators, as shown in Figure 3.

From the perspective of business law information management system, this paper considers the digital transformation mode of case enterprises from both business and financial aspects and takes the "intelligent business law information management system platform" applied in the digital transformation of manufacturing industry as the research object, combining business, digital technology, enterprise strategy, and other factors. First, this paper explores the current situation of "intelligent commercial law information management system platform" and analyzes the requirements from four aspects: efficiency management, risk management, information management, and fine management. In this paper, we evaluate and analyze the "intelligent commercial law information management system platform" with reference to the relevant natural environment carrying capacity assessment model and the comprehensive evaluation method of multiple indicators and then explore the optimization and development of the "intelligent commercial law information management system platform," so as to provide a framework for the subsequent development of digital transformation of manufacturing enterprises. The framework for the subsequent development of digital transformation of manufacturing enterprises is then explored.

Figure 2: The current situation of the construction of intelligent commercial law information management system of enterprises in China.

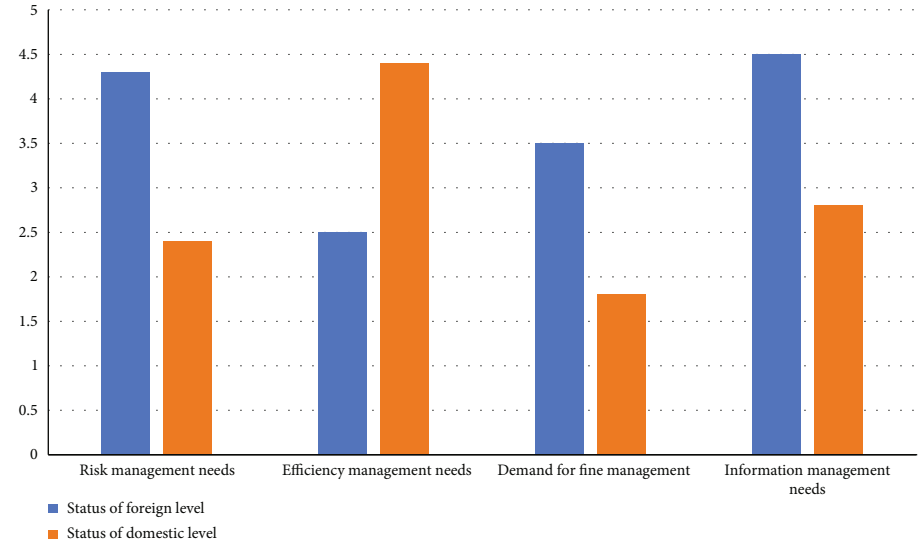

Figure 3: Enterprise intelligent commercial law information management system platform requirements.

3. Materials and Methods

3.1. Basic Theory

3.1.1. Big Data Collection and Management. The research content of this paper is about the discussion of the network literacy education system of college students under the big data media management mode. Therefore, the collection and management system of big data is to be utilized. The big data management system utilized today can not only store a large amount of data and form a large amount of data storage network system but also analyze and process the data extremely fast. Big data management system is to analyze and process all kinds of data by using the medium of computer and network reasonably. It is being used in various aspects of life in an increasingly fast and convenient way of digital information transmission and processing, which brings a great degree of information convenience to people's future learning life, updates the traditional view of data management, provides a more innovative and convenient way to store and process a variety of data, and greatly improves people's work efficiency [16]. The big data management system has four main features such as large storage volume, rapid information processing, real and effective data results, and a wide variety of data types, as shown in Figure 4.

3.1.2. Commercial Law. Commercial law belongs to a type of civil law and is added to the relevant legal sector as a supplementary law [16]. Commercial law is a law that regulates the equal commercial relations between different individuals, enterprises, and other subjects. Commercial law includes a wide range of laws, such as corporate law, credit law and related bankruptcy insurance, and other laws related to the economy. Of course, from the point of view of definition, commercial law is mainly to adjust different subjects of transactions, such as individuals, enterprises, government, and other subjects in their commercial behavior formed by

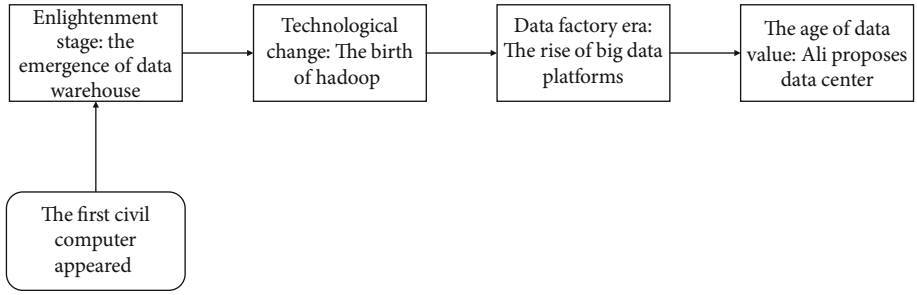

Figure 4: Characteristics of the data collection system.

some relations, this relationship is mainly commercial relations, so as the name suggests, the People's Republic of China commercial relations law, it is the name of commercial law. There is a rich variety of commercial law [17].

From the perspective of new institutional economics, the main purpose of commercial law in China is to reduce the related transaction costs in the future. The second is to ensure fairness for both easy parties. Ensuring the safety of the transaction process is carried out smoothly, and second, the process of the transaction is also regulated quite strictly; he can ensure that the transaction does take place. The last point in its function is that it ensures the improvement of the efficiency of the economy, which can increase the total social gain and reduce the total social cost, and in the process of business transactions can also increase the total gain and reduce the total cost of the enterprise [18].

The principle of honesty and trustworthiness is a relatively common civil and commercial law imperial clause under the modern industrial system, which plays a universal role of restraint and control in all types of market economies. The principle of honesty and trustworthiness will always be the primary principle of civil and commercial law as long as the market economy is in place. Of course, the principle of honesty and trustworthiness also imposes relevant requirements on the enforcement of law by law enforcement officers, which requires them to be able to enforce the law flexibly and with certain discretionary power [19].

Typical commercial laws are mainly corporate laws and related bonds, financial industry management laws related to note management, and related laws extended from here. The types of commercial law in China have been gradually enriched with the further development of reform and opening up, and the following ten main types of commercial law have been formed in Fujian, which have been used until now, as shown in Figure 5.

3.1.3. Information Management System. Enterprises improve the system data processing capability by introducing big data technology, so its information management system can provide multiangle data analysis for system users and enable enterprise managers to manage and supervise the enterprise from multiple perspectives. At the same time, the information management system should provide timely feedback of relevant information and facilitate the transfer of relevant data of the enterprise among various systems. The "intelligent business law information management system platform" includes cost management system, budget management system, performance management system, and decision management system; and each subsystem can realize its functional requirements with the help of the "intelligent business law information management system platform." In order to strengthen information management, enterprises should make use of advanced technology to optimize their information management and accounting platform to meet the changing needs of production management. In the general environment of information technology, the control of enterprise financial information system includes cost control and risk warning control. There are specific economic activities in the production process of enterprises, such as personalization of cars, which should be integrated into the management of business processes when analyzing their functional requirements. At the same time, with the help of big data and artificial intelligence technologies, it is possible to play a predictive role in process management in the business process. For example, process automation management in enterprises is being rapidly applied in the field of finance, while for repetitive and well-organized processes, an intelligent platform can help improve the efficiency of financial process management.

3.2. Research Methodology

3.2.1. Information Management System Evaluation Method. Set (Ω, ζ, P) up is a conceptual space, and x is the set of all wandering variables on the space involved. A risk measure ρ is a mapping x from a x_ρ subset of R to the real numbers, denoted as $\rho : X \in x_\rho \leftrightarrow \rho(X) \in R$.

First define the g function called distortion function, if $g : [0, 1] \longrightarrow [0, 1]$, it is a monotonically nondecreasing function and satisfies $g(0) = 0, g(1) = 1$.

$$\rho_g(X) \coloneqq \int_{-\infty}^{0} \lg\left(S_X(x)\right) - 1\Big) dx + \int_{0}^{\infty} \mathrm{g}(S_X(x))\Big) dx, X \in x. \tag{1}$$

Here is g the distortion function, which $S_X(x) = P(X \succ x)$ is X the tail distribution.

The X assumption is that the total risk faced $f : [0,\infty) \longrightarrow [0,\infty)$ by the insurer $f(X)$ is the partition function, representing the insurer transferring part of the risk faced by itself to the reinsurer. The reinsurer charges the insurer for the insurance premium to supplement the risk they bear

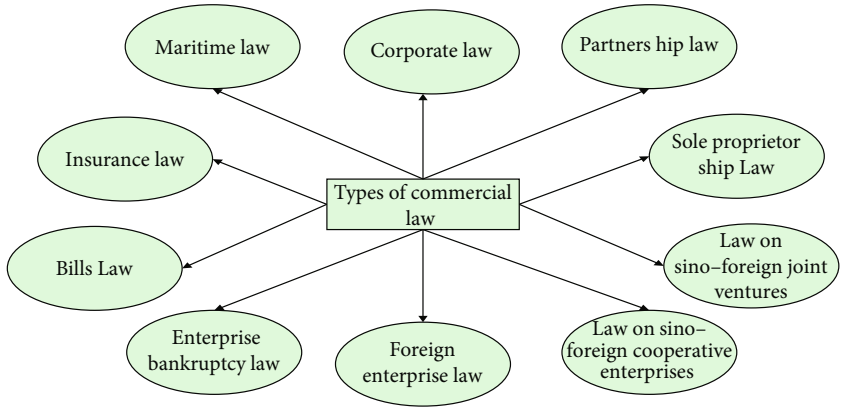

Figure 5: Types of commercial law.

because they assume a portion of the insurer's risk. This paper assumes that the reinsurance expense criterion has the following form.

$$\mu_r(f(X)) = \int_0^{\infty} r\left(S_{f(x)}(x)\right)dx, \tag{2}$$

where $S_{f(x)}$ is the $f(X)$ tail distribution of phi $r : [0,\infty) \longrightarrow [0,\infty)$ with respect to phi, which is a monotone nondecreasing $r(0) = 0$ function, phi has. Without loss of generality, we r assume that instead of being a function of zero almost everywhere, the total risk an insurer faces is the residual risk he will face plus the cost of transferring the risk. The formula can be expressed as

$$T_f(X) = X - f(X) + \mu_r(f(X)). \tag{3}$$

3.2.2. SQL Server Big Data Management System. On the basis of the mainstream Windows and other operating system platforms, SQL Server database as a new generation of database and analysis processing platform software is rapidly being widely used and widely accepted by enterprise customers. Different from other current database platforms such as FoxPro and smaller databases such as CCESS database, SQL Server has a complete powerful and easy to use database management and service processing functions, an engine that supports development, standard database languages such as SQL, and extended feature functions such as replication, OLP, and analysis. It is also clearly ahead of the rest of the market in other key features such as stored procedures and triggers that only large database software can provide [20].

Microsoft SQL Server 2010 is based on Microsoft SQL Server 7.0. It greatly expands database performance, reliability, quality management, and ease of use. Microsoft SQL Server 2010 Database edition is a high-performance enterprise relational database management system with high reliability and ease of use. SQL Server 2010 features are comprehensive and specific, as shown in Figure 6.

Therefore, this paper selects SQL Server 2010 for big data analysis, the first is SQL Server 2010 version has been

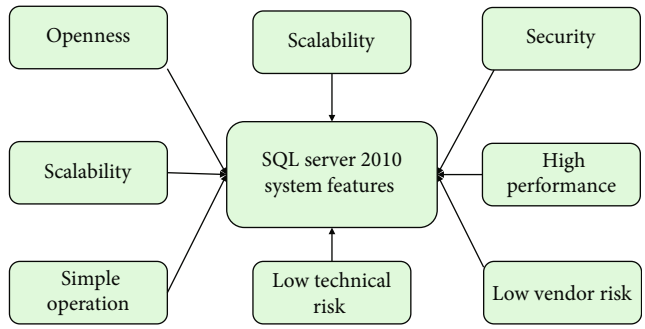

Figure 6: Main features of the SQL Server 2010 system.

relatively mature; second, SQL Server is used to manage large databases, that is, to analyze the use of big data, the use of this software is more appropriate. Finally, SQL Server is a more commonly used software for analyzing big data, which makes it easier for other researchers to understand this paper.

3.2.3. Oracle Big Data Analysis and Research. Oracle Database Management System, a database management system developed by the German company Oracle Software. It is probably another database product that Microsoft will design with distributed database as its core feature. It will also be one of Microsoft's most popular distributed C/S server architecture or distributed B/S database architecture in the world. State "questioning" is one of the most attractive performance advantages of Oracle's parallel Server model compared to SQL Server databases. It allows you to split any subquery into any number of subqueries and then execute the subroutines on two different server CPUs. Greatly improve the performance of multiprocessing systems, which should be a potential competitive advantage in the next few years of rapid growth of the data trend. The Oracle database has a number of other significant advantages over the Oracle database: complete data storage management storage capability. The data storage capacity is large, the persistence time is long, and the data can be shared, ensuring reliability. It has the features of perfect management function and simple operation, as shown in Figure 7.

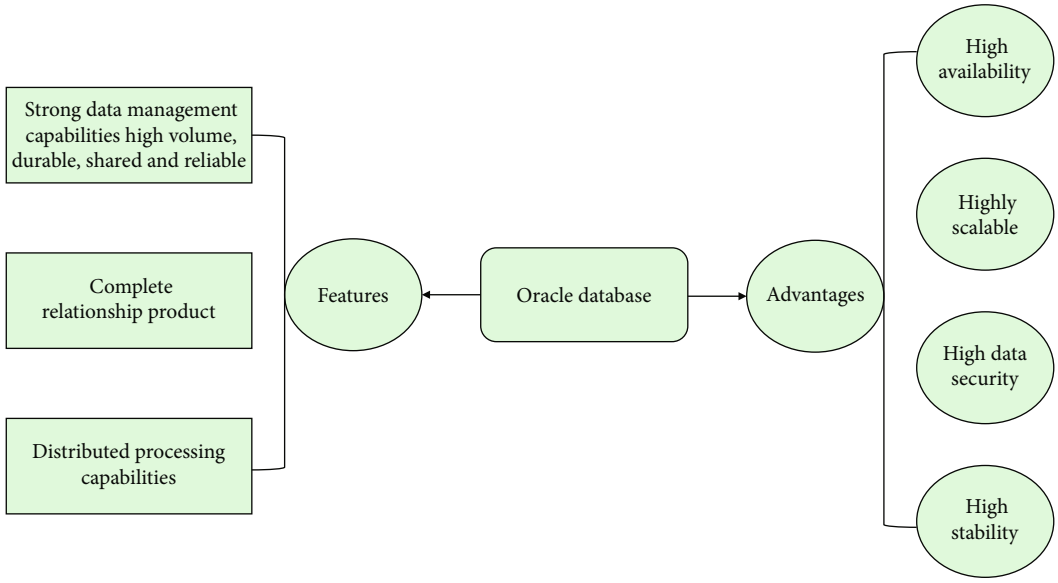

Figure 7: Features and advantages of Oracle database.

4. Results and Discussion

4.1. Demand Analysis of Enterprise Intelligent Commercial Law Information Management System Platform. The research on "intelligent commercial law information management system information platform" is still in its infancy, and the corresponding theoretical system is lacking. It is difficult to provide reference suggestions for the company in the realistic transformation process. Therefore, since the enterprise started the digital transformation strategy, the information system function of the commercial law information management system is relatively single, which needs to be further improved. At the same time, most of the "intelligent commercial law information management system information platform" used by Chinese traditional enterprises is divided into outsourcing software and independent research and development. The enterprise independently develops "intelligent Commercial law information management system information platform" by combining its own operation situation, to meet the daily operation and development of the enterprise. Therefore, this big data information platform, under the guidance of the enterprise's own development strategy, can ensure the transformation and upgrading of enterprise management, improve the management system, optimize business processes, and build a scientific organizational structure. Therefore, based on the analysis of enterprise industrial characteristics and platform function modules, this paper expounds the requirements of "enterprise intelligent commercial law information management system platform" from four aspects, namely, risk management, efficiency management, fine management, and information management, considering demand acquisition and demand transformation. Under the background of digital transformation, the intelligent commercial law information management system takes the integration of industry and finance as the transformation goal. The functional demand of "enterprise intelligent commercial law information management system platform" first faces the production demand of enterprises. The way of obtaining the production demand of enterprises is the new mode of modern manufacturing industry transformation and production. It is a demand acquisition mode based on the comprehensive comparison between customers' personal preferences and suppliers' needs to provide relevant services and improve the production value of enterprises. According to the industry characteristics of traditional vehicle manufacturing enterprises under digital transformation, the whole production demand acquisition process mainly consists of two aspects: demand service from customers: product demand analysis, production decision optimization, etc., and then give customers the overall planning solution to solve the corresponding demand; productive demand from suppliers: according to matching production demand, respond to the production workshop facing quality assessment, production rework, product design, and production resource problems when production capacity is insufficient. According to the above production demands, enterprises map to the "Enterprise Intelligent Business Law Information Management System Platform," and managers can take relevant measures immediately through the platform.

The digital unified management of the "intelligent business law information management system platform" supports the whole process, and the "intelligent business law information management system platform" obtains the enterprise production demand decision, and according to the customer demand and the service provided by the upstream production suppliers, the "Enterprise Intelligent Business Law Information Management System Platform" obtains the enterprise production demand decision, and according to the customer demand and the service provided by the upstream production supplier to make intelligent matching, generate the corresponding production and manufacturing plan. After that, the "Enterprise Intelligent Business Law Information Management System Platform" screens out matching production suppliers based on the

service demands of upstream suppliers, reshapes the production process according to the demand production plan, and is supervised by the enterprise production department to provide enterprise products and services to customers and suppliers. Production demand coordination and demand matching are the two processes of the first stage of demand acquisition and then realize the second stage of intelligent production and after-sales tracking. Production demand acquisition is an important part of the "intelligent business law information management system platform" to complete the decision-making service, which also provides the relevant basis for the demand analysis of each sub-system of the "intelligent business law information management system platform."

4.1.1. Demand Transformation Classification. Based on the understanding of the production demand acquisition mechanism of the "intelligent business law information management system platform," it can be found that the enterprise's customer and service demands need to be classified and summarized before being processed by the "intelligent business law information management system platform," and the enterprise by drawing on the transformation of various types of demand, the company reconstructed a more suitable demand strategy and planning. According to the characteristics of the manufacturing industry, the requirements can be divided into the acquisition of functional requirements knowledge, integration, and sharing. Therefore, this paper briefly describes the dissemination form and transformation mode of demand resources in each stage of "intelligent business law information management system platform" with the help of relevant functional demand acquisition model. As a kind of digitally available resource, the platform requirements can be divided into internal and external requirements acquisition channels by analogy with the idea of knowledge acquisition, and then, the two channels can be integrated. By integrating and summarizing the acquired demand resources from different knowledge sources such as external information system or customer's mind and converting them with the help of relevant digital technology such as computer language, enterprises can be recognized by the "intelligent business law information management system platform" and carry out digital process management and intelligent decision support.

4.1.2. Risk Management Requirements. The risks faced by the "intelligent business law information management system platform" cover the following points: first, the security of information obtained through the platform, such as the existence of financial differentiated information between systems and the risk of false transactions in the sales system; while the platform obtains the management information of the enterprise with its own information database, it needs to ensure the security of confidential information. Security issues, with the development of business, enterprise transaction data can be a reference basis for the production of risk management. Second, through the business on the cloud operation instead of manual management, although digital technology can be used to avoid operational risks brought about by manual errors, but also need to ensure that the quality of data audit, in order to avoid irreparable major risks arising. In addition, the platform also faces the unknown objective environmental risk crisis and needs to strengthen the continuous maintenance and data backup of the platform. Therefore, the "intelligent business law information management system platform" needs to help enterprises grasp the future strategic direction with the help of more predictable and refined enterprise core business data and then provide support for decision makers and effective management control of enterprises. For production planning and sales business, it is necessary to make prediction on project expectation, control the completion of any project task, make centralized planning and solution with the help of relevant functional modules of the platform, and then assist "intelligent business law information management system platform" to make effective judgment on the rationality of production planning and actual implementation of each process. Therefore, the current "intelligent business law information management system platform" cannot fully meet the needs of enterprise risk management.

4.1.3. Efficiency Management Requirements. The efficiency management of "intelligent business law information management system platform" includes business processes, financial management, and other types of delivery time differences, platform data processing efficiency, etc. Since the efficiency management of financial projects includes project payment management, payment confirmation time, and platform processing time, the combination of business optimization and digital technology can change the efficiency management of enterprises. It can be seen that, in addition to strengthening the "enterprise intelligent business law information management system platform," it is also necessary to link the sales management system to take the lead in screening good credit customer feedback to the financial system for priority payment, and thus shorten the payment time; based on this, the enterprise can improve efficiency and strengthen the control of capital flow and sales process at the same time. Second, in the reimbursement business, efficiency management is the focus of the "Enterprise Intelligent Business Law Information Management System Platform." In the validity management of financial statements, a credit evaluation model is built using the user's past data, exempting bills within a certain amount and giving priority to customers with good credit, and combining performance management and information management systems. Performance management and information management system are combined to achieve the purpose of collaborative management. The application of big data technology can replace part of the manual audit and improve the efficiency of the reimbursement business, but for the "enterprise intelligent business law information management system platform," there is a need for continuous planning efficiency management needs.

4.1.4. Demand for Fine Management. The refined management of "intelligent business law information management system platform" can realize the control of the whole process of production and operation activities of enterprises before, during, and after the event. At present, the "intelligent

business law information management system platform" is mainly responsible for the midevent record and postevent accounting, and the pre-event planning is relatively little reflected in the platform, which is difficult to meet the needs of the enterprise's intelligent business law information management system. Therefore, "intelligent commercial law information management system platform" needs to refine and reshape the business process of the enterprise, which helps the enterprise to grasp the whole business process comprehensively, not only limited to the core business process but also improves the refinement management to help the enterprise managers pay attention to the connection between each process. Overlapping, it can further promote the integration of enterprise business and finance and inject the management concept of business law information management system into business activities to achieve effective management control, thus eliminating the silo of information. Therefore, the current "intelligent business law information management system platform" is not well adapted to the enterprise's refined management requirements.

4.1.5. Information Management Requirements. It is easy to see from the iterative update of the digital transformation path that at this stage, the basic information such as production plan and financial statement required by the operation management of the enterprise are all counted by the production management system and ERP system and filled in by mail and office tools in aggregate. Therefore, the platform information silo has become one of the problems found in the digital transformation of enterprises, and how to realize data automation and establish an efficient internal management information transfer system has become one of the transformation guidelines of "Enterprise Intelligent Commercial Law Information Management System Platform." Although the "intelligent business law information management system platform" helps to collect a large amount of data and information from enterprises, without the establishment of an effective information integration platform, many information resources are only limited to use in a single department of the enterprise, which cannot give full play to the role of information resources and cannot bring positive significance to the operation and development of enterprises. Therefore, the "intelligent business law information management system platform" needs to reconstruct a suitable information interaction platform, accelerate information sharing, improve the speed of information circulation, and perfect information management needs.

4.2. Evaluation Analysis of Intelligent Business Law Information Management System Platform

4.2.1. Platform Selection and Applicability. The objective of the evaluation of the "intelligent business law information management system platform" in this paper is to explore the current situation of the digital transformation of enterprises and to formulate an optimization plan that can promote the digital transformation. Taking into account the digital transformation characteristics and strategic objectives of enterprises, the evaluation and analysis of the implementation status of the "intelligent commercial law information management system platform" will help enterprises determine the optimization path of the "intelligent commercial law information management system platform" and digital transformation. We will help enterprises to determine the optimization path of "intelligent commercial law information management system platform" and digital transformation. According to the previous demand analysis, the management goal of "intelligent commercial law information management system platform" needs to rely on the demand of each functional module to achieve; therefore, the platform evaluation should also take the improvement of each functional module demand as the subsequent optimization goal, and through the evaluation and analysis of the gradual optimization of relevant indicators in the platform, so as to finally achieve optimization and enhancement of "intelligent business law information management system platform."

In the digital transformation of enterprises, the evaluation indexes of "intelligent commercial law information management system platform" have a certain complexity and wide scope, and enterprises can only develop evaluation and optimization paths according to the mutual influence relationship between the demand management and evaluation indexes of the enterprise platform. Therefore, in view of the actual situation of "intelligent business law information management system platform" and the scarcity of relevant reference assessment literature, this paper borrows the natural environment assessment method—resource and environmental carrying capacity assessment, and its assessment concept is closest to the assessment plan of this paper. The concept of the assessment is closest to the assessment plan of this paper, that is, under the constraint of the environmental carrying capacity, to understand the enterprise's resource and environmental carrying status and development trend and use it as a basis for decision-making. We are looking for ways to further optimize the digital transformation and the "intelligent business law information management system platform" of the enterprise. Two models, PSR and DPSIR, are often used in regional resource and environment carrying capacity simulation studies. The PSR model can evaluate the coupling relationship between the influencing factors in the platform system and study the overall decision utility of the system through the interaction relationship between the systems, so it has certain applicability to the research problem of this paper. The model only focuses on the "growth limit" problem and lacks an early warning-oriented evaluation process for the current intelligent system platform. Wang Liang and Liu Hui combined the advantages and shortcomings of these two models, proposed a positive hexagonal interaction force model of resource and environment bearing based on the theory of "structural stability" and "growth limit," decomposed the environmental bearing capacity into the sum of multiple forces, and used the filling degree of the positive hexagonal model to determine the environmental bearing capacity. The filling degree of the hexagonal model is used to simulate the dynamic changes of the information carrying capacity and risk tolerance of the "intelligent business law

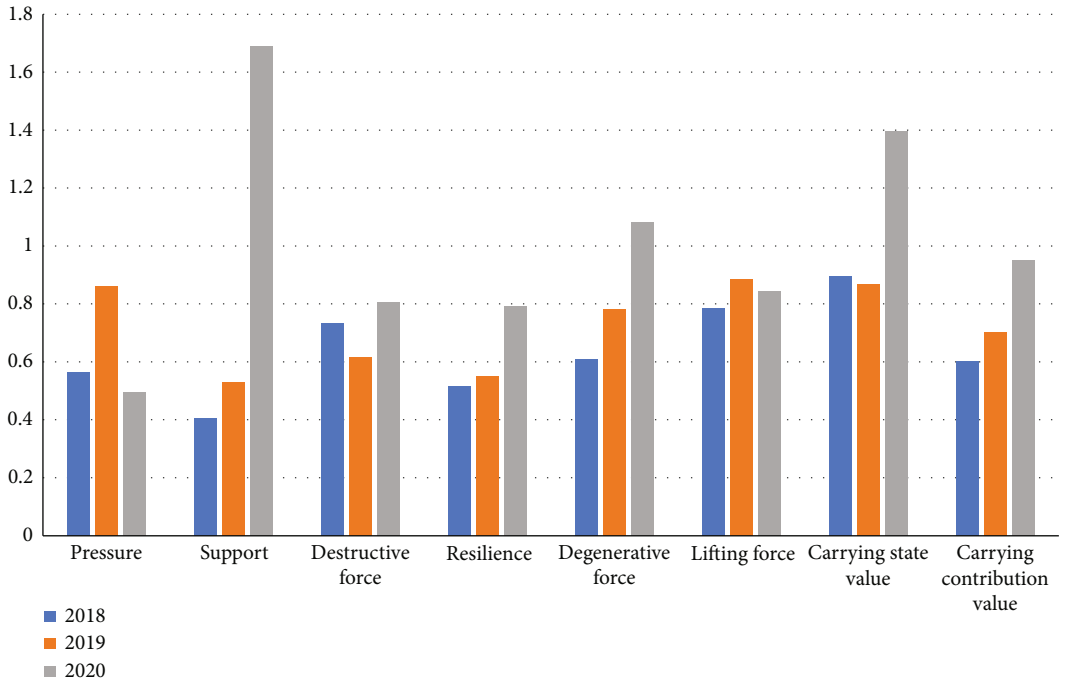

Figure 8: Comparison of the bearing state of the enterprise intelligent commercial law information management system platform from 2018 to 2020.

information management system platform," so as to form an evaluation system applicable to the "intelligent business law information management system platform of enterprises."

4.2.2. Comprehensive Analysis of Evaluation System Indicators. In recent years, the transformation from a traditional automobile manufacturer to an intelligent travel technology company is the main strategic goal of major automobile industries. Based on the demand of customer experience, traditional vehicle manufacturers build an automotive platform externally and an "intelligent business law information management system platform" internally to refine the management of each step of automobile manufacturing, sales, management, research, and development in fine detail and establish connections with close industries. In order to realize the digital reform of the whole enterprise, we have selected the enterprise as the research object. In this paper, the company is selected as the research object. Since the official announcement of the intelligent strategy in 2018, its internal "intelligent business law information management system platform" has been improved and adjusted on the basis of the previous ERP management platform. At the same time, after the establishment of the company's intelligent strategy, relying on social resources, the company has injected a large number of intelligent professionals to accelerate the digitalization process of the enterprise. With the advent of the era of the Great Intelligence, researchers from all walks of life and all disciplines are extremely concerned about the future of each intelligent "replaceable" profession. For the digital transformation of enterprises and other related manufacturing enterprises, most researchers believe that it is indisputable, therefore, through the relevant assessment of the "intelligent commercial law information management system platform" within the enterprise, to determine the environment in which the platform carries the state so as to determine the "intelligent commercial law information management system platform." Therefore, through the relevant assessment of the "intelligent commercial law information management system platform" within the enterprise, we determine the environmental bearing state of the platform and judge the mutual influence of the "intelligent commercial law information management system platform" and the digital reform of the enterprise. Further exploration is shown in Figure 8.

However, there are slight changes in the overall comparison, and the contribution value in 2019 represents the degradation and enhancement of the objective environment of the intelligent business law information management system. What is more, with the same concept that intelligent manufacturing industry is under increasing pressure, in 2019, China's auto industry production and sales volume is the first in the world, the revenue scale is 808.47 billion yuan, and the overall profit of the industry is declining, "intelligent business law information management system platform for enterprises" compared to 2018. In 2019, the information pressure has increased significantly, while the platform's destructive power has seen negative growth, as well as the platform's supporting power has maintained a faster growth rate, which together makes the overall development of the enterprise more stable, and at the same time, we will also consider the objective fact that the enterprise has a smaller volume of its own resources compared with the industry and is subject to lower external influence. Based only on the environment in which the enterprise is located and its own resources as the basis of analysis, the "intelligent

business law information management system platform" should be able to carry slightly more information than the current volume, while the "intelligent business law information management system platform" among manufacturing enterprises has a carrying capacity of is based on the existing information or resources of the enterprise, and the amount of information that can be carried within its capacity. The enterprise is closely coupled with upstream and downstream enterprises and loosely coupled with the platform system of other related enterprises, and the improvement of the platform's ability to obtain information can indicate the expansion of the carrying capacity of the "intelligent commercial law information management system platform."

5. Conclusion

China's manufacturing industry has set off a boom of digital transformation, and the commercial law information management system, as one of the important tools to enhance the intelligent management ability of enterprises, will also face a new round of reform and upgrade. Building an "intelligent commercial law information management system platform" is the primary transformation path for traditional manufacturing enterprises to realize intelligent upgrading of commercial law information management system. The "intelligent commercial law information management system platform" is a management information sharing service platform that enables enterprises to achieve the goal of collaborative management by integrating their own business models and product technology needs with the help of emerging digital technologies, which can help enterprises realize the organic integration of business processes, risk management, value creation, and other management needs and change the original. The platform can help enterprises realize the organic integration of business processes, risk management, value creation, and other management needs and change the focus of the traditional financial shared service center, so that the enterprise business law information management system can be shifted to the enterprise strategy-oriented, focusing on risk control, decision support, and other high-level management. Therefore, it is particularly important to evaluate and optimize the "intelligent business law information management system platform" of manufacturing enterprises in the process of digital transformation. In this context, this paper conducts a research and application of commercial law information management system based on big data, conducts an in-depth study on the current status of commercial law information management system in China, and provides an outlook on commercial law information management in China by establishing a relevant model system.

Data Availability

The dataset is available upon request.

Conflicts of Interest

The author declares no conflicts of interest.

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Research Article

Multidimensional Analysis of Physical Education Teaching Based on Big Data Action Scenarios

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Combined with the development of the current educational environment, physical education will replace English as the third subject of education in the future. The breakthrough in physical education teaching is also gradually changing from the general education form to today's smart education. In the era of big data, physical education can also apply this technology. In action scenarios based on big data, operations such as correction of detailed actions or monitoring and identification of key actions are common. Through the computer vision system, the rational judgment of the computer can be used to give follow-up training points. Also able to store personal data during training. The presentation of algorithms cannot be avoided through computer vision. Based on Action Bank as the basic algorithm, this paper proposes a template research method based on multispectral clustering and has been applied in Action Bank. The tedious manual template selection is eliminated. This method replaces it to facilitate its dissemination in different databases. In this method, due to the slow speed of extracting features, a fast algorithm of quantitative Action Bank is extracted. The experimental part of the article compares whether the algorithm has been optimized in terms of performance before and after optimization. The resolution, time consumption, and detection errors of the Action Bank model are carried out. The experimental exploration and data collection and comparison are carried out. After the experimental optimization, the performance has been improved. By comparing the meanshift detection method and spatiotemporal action detection method with the Action Bank model mentioned in this article, the experimental data of resolution, time consumption, and detection error are compared, and the Action Bank model is obtained in terms of resolution, time consumption, and error detection. The time consumption is better than the other two algorithm models, but there is room for improvement in detecting errors, but the experimental results also meet the current detection requirements, and in the current physical education teaching, it also occupies the forefront of this field, at the forefront. *Ministry of Education*. Instead of English, physical education has become the third subject! On April 21, the Ministry of Education released the "Compulsory Education Physical Education and Health Curriculum Standard (2022 Edition)," and the new curriculum standard will be officially implemented in the fall semester of 2022. Among them, the proportion of the total class hours of "Sports and Health" is 10-11%, surpassing foreign language to become the third major subject in the primary and early stages. Physical education has already started its journey. Traditional physical education can no longer meet the development of the current environment. The arrival of the information society has also brought about the development and progress of physical education. Only by better combining the current information technology can it be satisfied. The needs of physical education is in the future.

1. Introduction

Sports analysis based on big data action scenes, through a large number of dynamic videos and example galleries, combined with the presentation of algorithms, a large number of algorithm experiments and detection experiments are carried out [1–5]. After many experiments, it is ensured that the algorithm can complete the given motion tracking task and motion data acquisition task under the condition of meeting the time limit requirement [6–8]. However, based

on the processing of factors such as lighting conditions, contrast, and jitter rate [9–11], the computational and data acquisition costs of the algorithm tend to be higher and higher. Therefore, in this paper, all the variables considered above are regarded as irrelevant variables, it is only a single case of discussing the motion state of the object, and the Action Bank algorithm will present the tracking effect in real time [12–13]. Before this, the pose estimation of a single variable and the giving of the probability function are the core points of the algorithm, and the extraction and recognition of feature points that show correlation with it and the construction of the kernel function are the first steps in the algorithm [14]. Therefore, to complete the computer action, all parties need to be contacted and cooperate closely. The recognition of the human body and the estimation of the posture are jointly completed, which has practical value for physical education teaching [15].

Combined with the development of the current educational environment, physical education will replace English as the third subject of education in the future. The breakthrough of physical education teaching is also gradually changing from the general education form to today's smart education, etc., in the era of big data. This technology can also be used in physical education. In the action scene based on big data, the correction of detailed actions or the monitoring and identification of key actions are generally performed. Through the computer vision system, the rational judgment of the computer can give follow-up training. Points are also able to store personal data during training.

2. Multidimensional Analysis of Physical Education Teaching Based on Big Data Action Scenarios

This paper will complete the rapid and accurate identification, detection, and storage of sports-related activity data based on big data action scenarios [16–19]. The basic big data and physical education analysis is shown in Figure 1.

Based on the theoretical support of behaviorism and cognitivism learning theory, wisdom education, connectivism, the technical support of 3D energy characteristics, directional energy characteristics, and other technologies, this paper will jointly analyze physical education in big data action scenarios. This paper will design a feasible and scientific action collection model through the comprehensive application of the key technologies of motion data collection and human body model system plus theoretical support and can be effectively applied to basic physical education, such as the collection and collection of basic motion actions, demonstration of basic sports actions, and correction of sports actions, based on big data technology, it is very convenient to store and reference actions in the future [20–23].

2.1. Introduction of Action Bank Model

2.1.1. 3D Direction Energy Feature. The dynamic activities of people can be seen as the decomposition of energy in multiple directions. If effectively decomposed, then, the action of only one point can be considered, the energy of which can converge in different directions of the space-time cube. As an expression for the minimum activity level, this simplest decomposition is the most basic method for determining activity location [24, 25].

The decomposition of the energy in the space-time domain is achieved by a generalized filter of the third-order Gaussian derivative, which is labelled $G_{\widehat{3\theta}}(x)$, where $\widehat{\theta}$ is used to represent the direction of the filter at this point, and x represents the position of the energy in the space-time three-dimensional space at this point. The operation for a certain point energy set is as follows:

$$\tilde{E}_{\widehat{\theta}}(x) = \sum_{x\in\Omega}\left(G_{\widehat{3\theta}} * I\right)^2. \tag{1}$$

can be obtained by conventional methods using variable filters:

$$\widehat{\theta}_i = \cos\left(\frac{\pi i}{4}\right)\widehat{\theta}_a(\widehat{n}) + \sin\left(\frac{\pi i}{4}\right)\widehat{\theta}_a(\widehat{n}), \tag{2}$$

where $\widehat{\theta}_a = \widehat{n}\times\widehat{e}_x/\|\widehat{n}\times\widehat{e}_x\|$, $\widehat{\theta}_a = \widehat{n}\times\widehat{\theta}_a(\widehat{n})$, $\widehat{e}$ is a vector, and the range is in $0 \le i \le 3$, and the group can decompose the energy into any direction in the frequency domain, namely,

$$E_n(x) = \sum_{i=0}^{N} E_{\widehat{\theta}}(x). \tag{3}$$

$\widehat{\theta}(x)$ is one of several different directions in equation (2), each $E_{\widehat{\theta}}(x)$ computed with a directional energy filter.

In order to eliminate the influence of the direction energy itself and the corresponding relationship, it is necessary to unify the directions generated by equation (3), and it is necessary to divide the energy in each direction by the total energy:

$$\widehat{E}_{\widehat{n}i}(x) = \frac{\widehat{E}_{\widehat{n}i}(x)}{\left(\sum_{j=0}^{M}\tilde{E}_{\widehat{n}j}(x) + \varepsilon\right)}. \tag{4}$$

Expression M representing the number of energy directions is selected, and ε enters the value required to prevent some total energy from being too small to cause instability. Typically, ε a seventh energy measure is entered to indicate no structural action:

$$\widehat{E}_{\widehat{n}i}(x) = \frac{\varepsilon}{\left(\sum_{j=0}^{M}\tilde{E}_{\widehat{n}j}(x) + \varepsilon\right)}. \tag{5}$$

From the concept that using the formulas from (1) to (5), the energy spectrum of different planes in the space domain and the energy $x - y - t$ expressed in different directions of space can be extracted from the character activity sequence. The energy in different directions is decomposed into a point, the active sample template is combined with

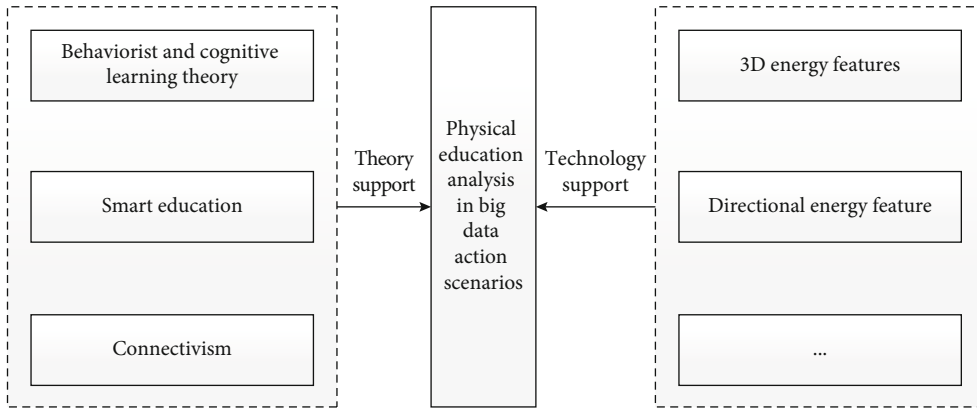

Figure 1: Basic big data and physical education analysis table.

the video waiting to be detected, and the positioning of the active sample can be carried out.

2.1.2. Template Matching of Directional Energy Features

(1) Space-Time Template Matching. To detect movement in large query campaigns, the 3D model needs to slide across all positions in the space-time cube. At each location, the similarity between the raw energy signature of the model and the directional energy within the coverage of the space-time cube at that point is calculated.

In order to comprehensively calculate the value of the matching degree $M(x)$, that is, the distance between the model and the query video position point, the directional energy in each channel calculates the distance separately.

The distance between the model position and the dynamic points, the directional energy of each point is calculated at the same time as the distance and then added together:

$$M(x) = \sum_{M} m[S(u), T(u-x)]. \tag{6}$$

Here u, moving along the three axes of space-time space $m[S(u), T(u-x)]$ refers to the similarity between the features S of the query task activity and the template features T.

In fact, many methods for calculating the relativity of histograms can be used to calculate the similarity between energy characteristics, and the Babbitt coefficient is used here. For histograms p and histograms Q, if each contains a channel, the Bap coefficients are defined as follows:

$$m(P, Q) = \sum_{b=1}^{B} \sqrt{P_b Q_b}. \tag{7}$$

The calculation of the correlation value is limited between 0 and 1, with closer to 0 indicating a complete mismatch, and closer to 1 the higher the similarity.

The final step of detection selects M the most likely matching point in the space-time cube, which is the most likely template movement position. The local maxima of the space-time cube are achieved under low braking.

(2) Template Matching of Assigned Values. In tasks that match a specific template, it may be necessary to set different values for different areas of the template. This can be done by changing the global negotiation function:

$$M(x) = \sum_{M} w(u) m[S(u), T(u-x)]. \tag{8}$$

(3) Height Matching. In the previous field of pattern recognition, high matching usually consists of several methods: (1) transition from fuzzy to clear search using spatiotemporal pyramids, (2) preliminary estimation of the requester's location from particle samples, (3) evaluation using template subclasses, and (4) the matching calculation is terminated early. The results of these calculations can lead to target loss. The method used to determine the motion position is described here. In equation (7), the mode distance is equal to calculating the sum of the associations between each channel:

$$M(x) = \sum_{b} \sum_{u} \sqrt{S_b(u)} \sqrt{T_b(u-x)} = \sum_{b} \sqrt{S_b} * \sqrt{T_b}. \tag{9}$$

This $*$ represents interrelated operations, and b represents the index number of bins.

Therefore, the correlation distance can be efficiently calculated using the convolution theorem from Fourier transform to frequency space, so that the time-consuming correlation operation in complex space becomes the multiplication of space points in the frequency range:

$$M(x) = F^{-1}\left\{ \sum_{b} F\left\{ \sqrt{S_b} \right\} F\left\{ \sqrt{T_b'} \right\} \right\}. \tag{10}$$

Expressions $F\{\cdot\}$ and $F^{-1}\{\cdot\}$ represent the Fourier transform and the inverse Fourier transform, respectively, and T_b' represent the corresponding templates. In the implementation process, the Fourier transform can be effectively realized by the fast discrete Fourier transform.

2.1.3. Complexity Analysis. Let $W_{\{T,S\}}$, $H_{\{T,S\}}$, and $D_{\{T,S\}}$ specify the width, height, and frame number of the template video T and the video to be detected, respectively. The S Action Bank algorithm can be regarded as two parts, one part is the generation of 3D directional energy features, and the other part is the combination based on this feature. The time at which the 3D directional energy feature $O(W \times H \times D \times k)$ appears as, where k represents the length of the filter. In the matching process, equation (6) points out the complexity of the space-time field matching based on the Buckley coefficient:

$$O\left(B \prod_{i\epsilon\{T,S\}} W_i H_i D_i\right). \tag{11}$$

Formulas (2)–(10) convert the correlation operation into the frequency domain product and divide the 3D FFT into 1D FFT for calculation, and the complexity is

$$O[BW_S H_S S_S(\log_2 D_S + \log_2 W_S + \log_2 H_S)]. \tag{12}$$

It can be obtained that an efficient template matching method is adopted in the frequency range, which greatly reduces the computational complexity in the matching process and enables the directional energy characteristics to be processed quickly.

2.1.4. Extracting Features for Motion Localization. Dynamic motion can be regarded as energy moving in different directions, then when only one point is considered as energy, if it can be effectively decomposed, it can be regarded as the combination of energy in different directions for this point on the space-time cube. This decomposition is the lowest and most basic activity expression in the positioning algorithm.

The energy decomposition in the space-time cube is achieved by a 3rd-order Gaussian derivative and a three-bit filter, which can be written as $G_{3\theta}(x)$, where θ represents the direction of the filter at that point, and the unknown x represents the point position in the spacetime cube. Among them, the value of the point corresponding to the video to be detected around the point Ω of the filter is

$$E_{\widehat{\theta}}(x) = \sum_{x=\Omega} (G_{3\theta} * I)^2. \tag{13}$$

Third-order filter banks can be obtained with conventional tunable filters:

$$\widehat{\theta}_i = \cos\left(\frac{\pi i}{4}\right)\widehat{\theta}_a(\widehat{n}). \tag{14}$$

The correct way to write this formula should be

$$\widehat{\theta}_i = \cos\left(\frac{\pi i}{4}\right)\widehat{\theta}_a(\widehat{n}) + \sin\left(\frac{\pi i}{4}\right)\widehat{\theta}_b(\widehat{n}), \tag{15}$$

where $\widehat{\theta}_a = \widehat{n} \times \widehat{e}_x / \|\widehat{n} \times \widehat{e}_x\|$, $\widehat{\theta}_a = \widehat{n} \times \widehat{\theta}_a(\widehat{n})$, $\widehat{e}$ is a vector, the range is in $0 \le i \le 3$, and the group can decompose the energy into any direction in the frequency domain, namely,

$$E_n(x) = \sum_{i=0}^{3} E_{\widehat{\theta}}(x). \tag{16}$$

$\widehat{\theta}(x)$ is one of several different directions in equation (2), each $E_{\widehat{\theta}}(x)$ is computed with a directional energy filter.

Finally, it is found that rest energy E_x and unstructured energy have E_o nothing to do with motion, they can be used as separation salient energy, and other five kinds of energy can be obtained. These five energies can be set uniformly and finally form five channels of eigenvalues.

For the Action Bank detector, it defines 7 original space-time energies, they are static function E_x, leftward energy E_i, rightward energy E_r, upward energy E_a, downward energy E_d, flickering energy E_j, and unstructured energy E_o.

The added formula is

$$\bar{E}_i = E_i - E_s - E_o. \tag{17}$$

3. Improvement and Optimization of the Algorithm

If a hyperplane is found by a linear classifier in a dimensional vector, then, there is the following equation:

$$w^T x + b = 0. \tag{18}$$

There is one, the two-dimensional plane hyperplane is a straight line, w is the normal vector, and b refers to a segment on the intercept. After obtaining the hyperplane, the formula of the classification function will become:

$$f(x) = w^T x + b. \tag{19}$$

As can be seen from the formula, $f(x) = 0$ the points x are points at the hyperplane, $f(x) < 0$ or $f(x) > 0$, the samples to be classified can be divided into two categories. So $f(x) < 0$, the categories of y sum can be +1 sum and $f(x) > 0$, respectively, −1.

From the point to the hyperplane is expressed by the certainty or validity of the classification result $\|w^T x + b\|$. Absolute values can be removed by using categorical markers and then entering the y formula for the interval between functions:

$$\widehat{y} = y\left(w^T x + b\right) = yf(x). \tag{20}$$

Since the size of the range of the function is affected by the size of the set parameters, for example, the parameters $\|w\|$ and $\|b\|$ are modified proportionally, and the range of the function will also be affected and will be changed proportionally, so the geometric range is introduced to adjust the range of the function:

$$\widehat{y} = \frac{\widehat{y}}{\|w\|} = y\left(\frac{w^T}{\|w\|}x + \frac{b}{\|w\|}\right). \tag{21}$$

Table 1: Experimental simulation data table.

Example	Action data storage(s)	Action error detection times	Action correction times	Error correction rate (%)	Satisfaction (%)
Running action	162	36	Twenty three	63.8	80.6
Shooting action	195	45	30	66.7	85.3
Table tennis swing	145	33	Twenty one	63.6	96.3
Badminton swing	207	56	31	55.3	84.2

Table 2: Experimental data comparison table.

Example	Error detection times	Error correction times	Effective error correction	Error correction rate (%)
Traditional physical education	8	8	8	100
Action Bank model	16	12	10	75

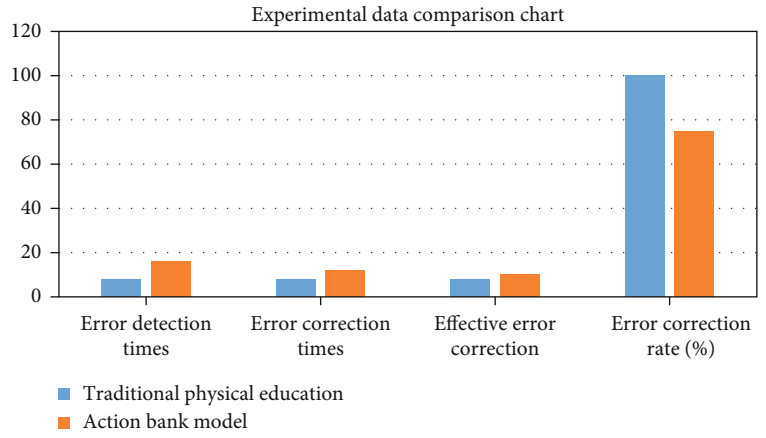

Figure 2: Experimental comparison diagram.

As the interval of the geometric interval becomes larger and larger, the confidence of the classification becomes higher and higher. When the training example T contains n points, we will make these n points have a reasonable distance from the reference vector in the hyperplane.

The biggest problem in the optimization of w and b parameters in the hyperplane range is the problem of geometric intervals:

$$\max \widehat{\gamma} \text{s.t.} y_i\left(w^T x_i + b\right) = \widehat{\gamma}_i \geq \widehat{\gamma}. \tag{22}$$

The interval of the value will change with the change of the parameters. In order to facilitate the optimization and export of the function, the interval of the function is substituted by $\widehat{\gamma} = 1$, and the following formula is obtained:

$$\max \frac{1}{\|w\|} \text{s.t.} y_i\left(w^T x_i + b\right) = \widehat{\gamma}_i \geq \widehat{\gamma}. \tag{23}$$

The equation can also be written in the following form:

$$\min \frac{1}{2}\|w\|^2, \text{s.t.}, y_i\left(w^T x_i + b\right) \geq 1. \tag{24}$$

Table 3: Comparison of detection amount and resolution (%).

Example	Primary model	Optimization model
Running action	69.2	70.56
Shooting action	79.3	82.01
Table tennis swing	85.2	87.21
Badminton swing	85.6	86.24

The quadratic programming problem with linear constraints introduces Lagrange multipliers α, and the objective function is as follows

$$L(w, b, a) = \frac{1}{2}\|w\|^2 - \sum_{i=1}^{n} a_i\left(y_i\left(w^T x_i + b\right) - 1\right). \tag{25}$$

Converted to the dual problem, fixed α, minimize the w sum with b respect to the objective function L:

$$\frac{\partial L}{\partial w} = 0 \Rightarrow w = \sum_{i=1}^{n} a_i y_i x_i. \tag{26}$$

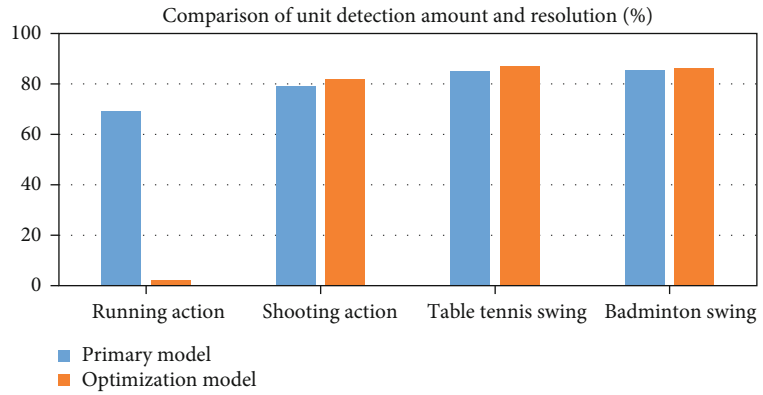

Figure 3: Comparison of bit detection amount and resolution.

Formula (26) in the article is solved together based on the formula (25), but only one formula cannot be obtained, and another formula should be added to solve it together.

$$\frac{\partial L}{\partial w} = 0 \Rightarrow \sum_{i=1}^{n} a_i y_i = 0. \tag{27}$$

From equation (27) into equation (26), we can get

$$\max \sum_{i=1}^{n} a_i - \frac{1}{2}\sum_{i=1}^{n} a_i a_j y_i y_j x_i^T x_j \text{s.t.}, a_i \geq 0, i = 1 \cdots n. \tag{28}$$

Equation (28) can be quickly solved by the sequence minimum optimization algorithm, which ensures the efficiency of the SVM algorithm.

4. Experimental Simulation

In Action Bank, hand-picked templates were chosen with an average pixel of 50, 120, and a time length of 40-50 frames.

Traditional physical education can no longer be satisfied. In the current educational environment, based on the technology of Action Bank, a multidimensional analysis of physical education is carried out. Traditional sports can only provide simple action guidance for human actions under the intuitive vision of the human body. However, in the big data motion scene, it is possible to store the data of the human body dynamic motion accurate to the frame, to score and correct the accuracy of the dynamic motion, and to match the corresponding data based on the stored dynamic motion data. Intuitive analysis of sports. Now, with the technology of Action Bank, the experimental simulation of the existing sports actions is carried out to compare the improvement of the Action Bank model compared with the traditional physical education. Now conduct model experiments based on a certain action data, and get Table 1, as shown in the table.

The above is a demonstration of the experimental data after the model simulation experiment. It can be seen that the error correction rate of the experimental dynamic data is still maintained at more than half. Now, the same example is artificially tested, and then, the obtained data are compared. Table 2 is as shown in Figure 2.

Table 4: Time consumption comparison of detection amount (unit : second).

Example	Primary model	Optimization model
Running action	1.1	0.8
Shooting action	1.3	0.9
Table tennis swing	1.4	1.0
Badminton swing	1.3	0.8

As shown in the table, it can be intuitively found that the traditional physical education is manual inspection, so the error detection, error correction, and effective error correction are all the same, but the effective error detection of the model is more than the manual error detection by 2. From this, it can be seen that manual error detection will still be more or less affected by factors such as environment, man-made, and force majeure, while the model will not be affected by so many factors, unless there is an error in the algorithm itself, the shortcomings of the model are reflected in the correction. The error rate may be due to the lack of control data. In the future experiments, the basic behavior will be stored, and the database will be improved to achieve the optimal operation of the model.

4.1. Performance Comparison before and after Model Optimization. Now collect and collect an example action in a big data action scene. By comparing the resolution of the experiment, the consumption of recognition time, and the number of recognition errors, it is concluded whether the optimization of the model has a substantial effect on the model. Promote.

4.2. Fiction Resolution Comparison. Comparison of unit detection volume and resolution is as shown in Table 3 and as shown in Figure 3.

It can be seen from the figure that the blue one is the primary model, and the orange one is the optimized model. It can be seen intuitively that the optimized model has a significantly improved resolution than the primary model. According to

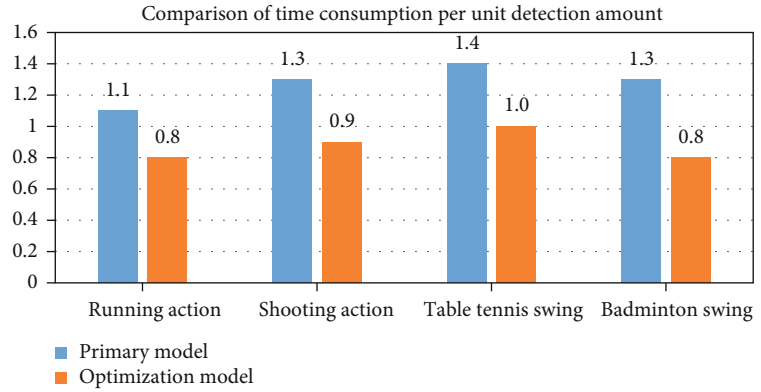

Figure 4: Time consumption comparison diagram of detection amount.

the table, it can be seen that in the resolution data, there is also a significant improvement in accuracy.

4.3. Time Consumption Comparison of Unit Detection Amount. In the action scene of big data, the time requirements for detection are relatively strict, and the general detection must ensure the timeliness, so that the data obtained from the detection can be effectively used.

Comparison of time consumption per unit detection amount is as shown in Table 4 and as shown in Figure 4.

The figure shows that the blue one is the primary model, and the orange one is the optimized model. It can be seen intuitively that the time consumption of the optimized model is shorter, and it can better meet the requirements of the experiment for timeliness.

4.4. Comparison of the Number of Recognition Errors per Unit Detection Amount. The detection of model performance can be intuitively analysed by the number of errors in the number of experiments. By comparing the number of errors before and after the optimization of the experimental model, the performance of the model before and after optimization can be compared, as shown in Table 5 and as shown in Figure 5.

In the figure, the blue one is the primary model, and the orange one is the optimized model. It can be seen intuitively that after the model is optimized, the number of detection errors has dropped significantly, meeting the performance requirements of the experimental model.

To sum up, the performance of the optimized model is more in line with the inspection requirements, the resolution of the experiment is optimized, and the motion data obtained by the inspection can be stored more accurately. The reduction in the number of recognition errors is an essential improvement in the performance of the model.

Tables 1 to 3 in the article are mainly for the comparison before and after the optimization of the algorithm used in the article, based on the simulation and data collection of the experiment based on the resolution of the algorithm data, time consumption, and the number of detected errors. Finally, the experimental results are obtained, and the optimized algorithm is much better than the initial algorithm in terms of resolution, time consumption, or the number of detection errors.

Table 5: Comparison of the number of recognition errors per unit of detection.

Example	Primary model	Optimization model
Running action	8	2
Shooting action	5	1
Table tennis swing	6	2
Badminton swing	12	5

4.5. Performance Comparison before and after Model Optimization. Based on the experimental data in Section 4.2 of the article, this paragraph compares the algorithm used in this article by introducing the meanshift algorithm and spatiotemporal detection method and compares the resolution, time consumption, and number of detection errors. The Action Bank model used in this paper is better than the other two algorithms in terms of resolution and time consumption, but it is slightly inferior to the spatiotemporal detection method in the number of errors in checking. Therefore, in the future algorithm optimization and improvement, it will be more inclined to modify the detection of the algorithm.

By introducing the meanshift detection method and the spatiotemporal action detection method, the action scenes of several cases are detected and analysed, and the experimental models or algorithms are compared by comparing the resolution, time consumption, and number of experimental errors of the experiments. Finally, the Action Bank model is obtained. Whether it meets the requirements for detection in terms of performance.

The meanshift algorithm refers to the use of the gradient of the probability density to solve and find the optimal solution.

4.5.1. Spatiotemporal Detection Method. The early spatiotemporal action detection is to process frame by frame to obtain the bounding box and action category of the characters in each frame and then connect these boxes along the time dimension to form the spatiotemporal action detection result.

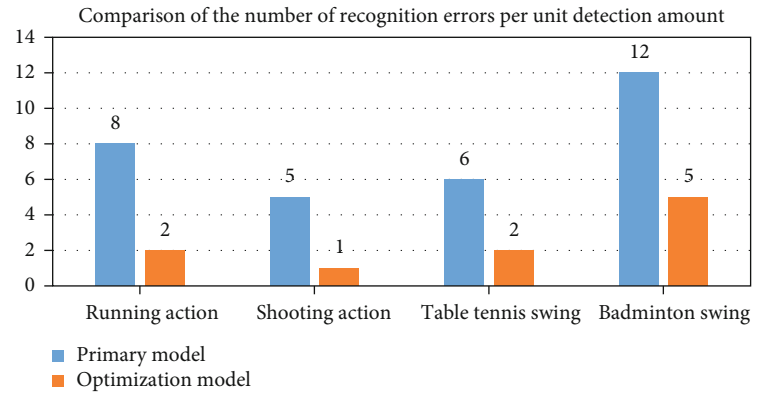

Figure 5: Comparison of the number of recognition errors per unit detection amount.

Table 6: Comparison of resolutions (%).

Example	Action Bank model	Meanshift detection method	Spatiotemporal motion detection
Running action	70.56	65.2	67.3
Shooting action	82.01	79.3	81.2
Table tennis swing	87.21	85.3	86.6
Badminton swing	86.24	83.3	84.3

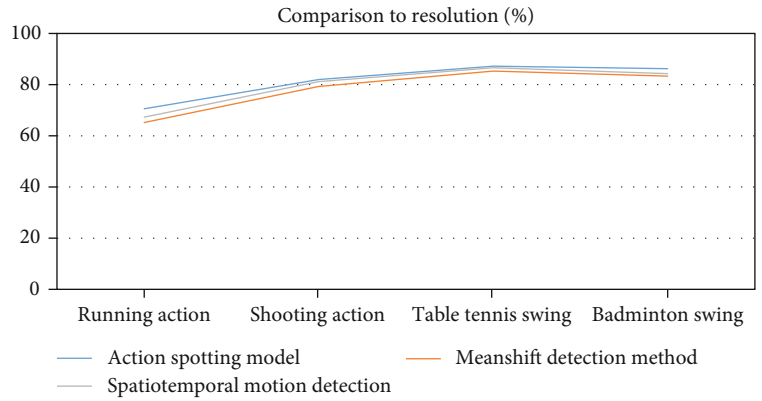

Figure 6: Comparison of resolutions.

Now for the detection of the experimental resolution, based on the data collected and sorted out, the results are shown in Table 6, as shown in Figure 6.

In the figure, the blue is the Action Bank model, the orange is the meanshift detection method, and the gray is the spatiotemporal action detection method. It can be seen intuitively from the figure that the blue line in the figure is the resolution data of the Action Bank model. Both are at the top of the datasheet, and it follows that the Action Bank model is superior to the other two models in terms of resolution.

The time consumption of the referenced model or algorithm is now tested to determine whether the timeliness of the model or algorithm meets the testing requirements. The testing data is shown in Table 7, as shown in Figure 7.

In the figure, the blue one is the Action Bank model, the orange one is the meanshift detection method, and the gray one is the spatiotemporal action detection method. You can intuitively see the blue line, that is, the Action Bank model time consumption data is at the lowest end of the table. It can be concluded that the model is better than other models in terms of time consumption, but based on the consideration of timeliness, the time consumption of all models meets the requirements for timeliness.

The number of inspection errors is the most intuitive data comparison for the performance of the model or algorithm. The results of the inspection data are shown in Table 8, as shown in Figure 8.

In the figure, the blue one is the Action Bank model, the orange one is the meanshift detection method, and the gray

Table 7: Comparison table of inspection time consumption (unit: second).

Example	Action Bank model	Meanshift detection method	Spatiotemporal motion detection
Running action	0.8	1.1	1
Shooting action	0.9	1.3	1.1
Table tennis swing	1.0	1.5	1.3
Badminton swing	0.8	1.3	1.2

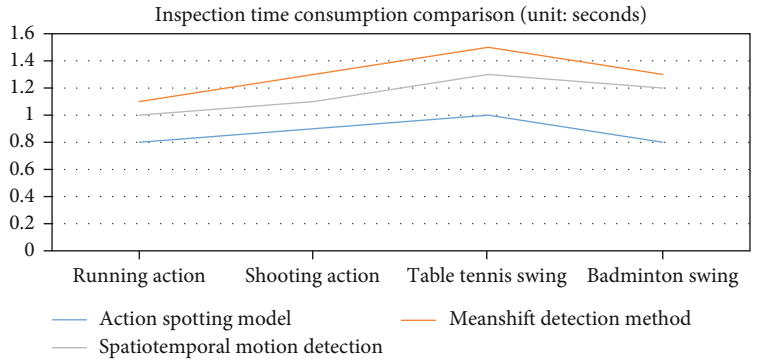

Figure 7: Comparison table of inspection time consumption.

Table 8: Comparison table of the number of inspection errors.

Example	Action Bank model	Meanshift detection method	Spatiotemporal motion detection
Running action	2	3	1
Shooting action	1	2	2
Table tennis swing	2	4	1
Badminton swing	5	6	2

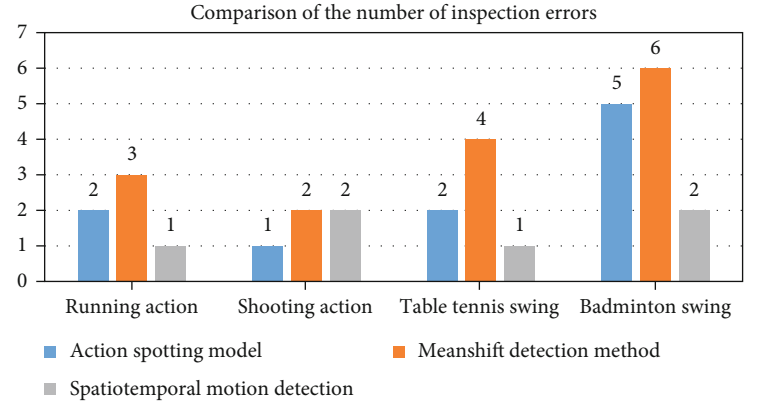

Figure 8: Comparison of the number of inspection errors.

one is the spatiotemporal action detection method. It can be seen intuitively that in the table, the data of the gray part of the spatiotemporal action detection method is relatively lower than the rest. There are two models and algorithms, but the number of errors of the Action Bank model is also within the scope of the inspection requirements, so it basically meets the requirements in terms of performance.

Tables 4 to 6 of the article are experimentally compared with the algorithm used in this article by introducing the meanshift algorithm and spatiotemporal detection method, and by comparing the resolution, time consumption, and number of detection errors, and finally get the results used in this article. The Action Bank model is better than the other two algorithms in terms of resolution and time

consumption, but it is slightly inferior to the spatiotemporal detection method in the number of errors in checking. However, the requirements for detection are also met.

To sum up, the Action Bank model is better than the other two models and algorithms in terms of resolution and time consumption. Although it does not perform relatively well in terms of the number of detected errors, but based on performance considerations, the Action Bank model fully meets the requirements and provides directions for the future development and optimization of the model.

This paper studies the human activity recognition and retrieval of big data videos, improves the application of the Action Bank method in the context of big data, and has achieved satisfactory results, but there are still deficiencies in some aspects and room for improvement. In the future work, the author will continue to seek improvements in at least the following two points: (1) the method of template learning and (2) the setting of the parameters of the quantization Action Bank algorithm.

5. Conclusion

Combined with the above, the article compares the resolution, detection time consumption, and number of detection errors before and after the optimization of the model through experimental simulation and obtains the experimental data. It is concluded that the performance of the optimized model is significantly improved than that of the primary model. Then, the meanshift detection method and the spatiotemporal action detection method are introduced. By comparing the resolution, detection time consumption, and detection error times of these two algorithms with the Action Bank model, the resolution and detection time of the Action Bank model are obtained. The consumption is better than the other two algorithms, but it is weaker than the spatiotemporal detection method in terms of detecting errors. Meet the trends of the current environment.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

Acknowledgments

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Retraction

Retracted: Construction and Application of Physical Education Teacher Literacy Evaluation System Based on Grey Relational Model

Journal of Sensors

Received 23 January 2024; Accepted 23 January 2024; Published 24 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] X. Kong and D. Guo, "Construction and Application of Physical Education Teacher Literacy Evaluation System Based on Grey Relational Model," *Journal of Sensors*, vol. 2022, Article ID 5448213, 12 pages, 2022.

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Research Article

Construction and Application of Physical Education Teacher Literacy Evaluation System Based on Grey Relational Model

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With the development of our country, more and more attention is paid to the education of students. However, the issue of teachers' literacy is the one that has the greatest impact on students in the campus. This paper makes an in-depth study and discussion on the quality evaluation system and application of physical education teachers. Better improving the literacy of physical education teachers also has a more positive impact on student education. The following conclusions are drawn from the research and analysis: (1) The basis of selecting evaluation indicators and the corresponding evaluation process for the evaluation of physical education teachers'literacy are multifaceted, and the evaluation criteria should be fully considered. (2) For the construction of the grey relational model, its algorithms are divided into many categories, and different algorithms are applied to different situations of relational degree. The grey relational model based on point relationship and generalized range is introduced, which provides convenience for subsequent computational research. (3) The difference between the basic information distribution and teaching quality of physical education teachers was obtained through the investigation experiment. The form of questionnaire survey determined the specific indicators of evaluation and the distinction between the first and second grades. Through multiple sets of experiments, the main evaluation indicators and the grey correlation degree of teacher literacy are tested, and the correlation degree between evaluation indicators and teacher literacy is obtained.

1. Introduction

Public-private integrated circuit production forecasts have important economic value in the world economy. Policy adjustments and portfolio reviews and IC industry development information have important implications for governments, policymakers, and stakeholders. In recent years, many researchers have proposed a series of forecasting techniques suitable for high-tech industries. Most of these methods are based on statistical studies related to the use of univariate time series data. However, these models do not give clear insight into the predicted outcome. Combining grey multivariate model with grey relational analysis, a new forecasting method is proposed. The results show that the planning portfolio method has obvious improvement over traditional methods in terms of forecasting techniques and survey variables. The significance of its management and future research directions was discussed [1]. Aiming at the problem that the uncertainty information cannot be described in the traditional grey relational model, a new grey relational model based on grey sequence is established. Design method: On the basis of the definition of the traditional grey relational model, taking into account the limitations of information and knowledge, the grey number algorithm is combined with the grey relational model. General formulas for grey process and grey distance are defined. According to the definition of grey distance, grey relational model and grey geometric relational model based on grey sequence are proposed. Finally, the parallelism, multiplicity, and system conservation of the model are discussed [2]. Although the problem of diagnosis has been extensively discussed in many studies and applied comprehensively in various fields, the literature indicates that there are certain limitations in practical application.

In order to expand the application frontier, a practical expert diagnosis model is proposed, which mainly adopts the grey relational analysis technique, that is, the data analysis method based on the generalized distance function to distinguish normal objects and abnormal objects. The concept of how to map regular objects around reference points in a multidimensional space is presented and explained. Therefore, anomalous objects can be determined by judging that the distance between a given anomalous object and a reference point exceeds a threshold [3]. In order to improve the grey analysis method, and the evaluation accuracy is not high, a new evaluation model is established by integrating physical theory. According to the change of index value, the model reflects the utility of data and information content, implements the evaluation model of regional rain resource development potential, and avoids the influence of subjective factors. The evaluation results show that it is scientific to introduce physical theory into grey correlation analysis. The rationality of the model is put forward to improve the evaluation accuracy of grey scale analysis method [4]. Each item has points, and the total score determines the winner. However, the grading table and the class spacing of its assigned units seem unreasonable. To overcome this shortcoming, a complete and accurate evaluation model is built using the grey relational degree derived from grey theory to determine who is the best all-around athlete in all championships. This approach not only reduces scoring disputes, but also helps teams select the best athletes. Using the grey relational analysis method, numerical analysis was carried out on the ranking of typical decathlon competitions. This approach could provide an improved scoring method for World Games or other sports federations to determine who is the best all-around athlete among all athletes [5]. Aiming at the problem that BP artificial neural network cannot automatically select and optimize the input variables, the BP artificial neural network algorithm (GM-BPANN) is optimized by combining BPANN with grey relational analysis. By comparing the data of grain production in China and the stepwise regression method with the transgenic (1, N) grey method, it can be found that the new model can deal with a large number of input variables, improve the adaptability of BP neural network, and has a better effect without special subjective selection. Good stability and accuracy [6]. Set pair analysis (SPA) is a new systems theory method for analyzing factual ambiguity and uncertainty. Applying similarity and difference expressions can resolve many ambiguities and uncertainties. Aiming at the problem that the existing lake eutrophication evaluation methods are too complicated, a lake eutrophication evaluation method based on grey relational degree is proposed. The evaluation results are consistent with other evaluation methods [7]. As a kind of exhibition industry, convention and exhibition are highly valued by countries all over the world. In INA, the development of this industry is very good. We use the corresponding grey model to determine the uniform effect, and use the grey relational analysis method to analyze the economic development. It objectively reflects the level of economic development [8]. Lantern gearbox is an important part of transmission system. Combining the physical model formed by simulation symbols, the three-step statistical algorithm of evaluating feature selection and grey correlation analysis, an ambitious method for gear blade damage is designed. Firstly, the fault data is tested and analyzed through the training data, and then the validation set is verified. The design results of experimental data are consistent with the actual test records, which prove the value and accuracy of this method. According to the health law and national forecasting methods, characteristics, and trading methods, it provides a new selection method and trade-off method [9]. Improving students' learning motivation is one of the basic problems faced by physical education teachers. From a goal achievement perspective, guidelines need to be established for more effective use of information in the classroom. This study examines the relationship between the motivational climate created by PE teachers and the intrinsic motivation of precompetition classes, precompetition self-confidence and anxiety, and precompetition and post-competition emotional states. Physical education teachers manipulate the atmosphere of motivation and adjust the strategies of goals. Mastery atmosphere is associated with fun, perception, and effort in physical education class, precompetition physical anxiety, and post-competition vitality [10]. It gets the reasons why people choose sports and studies the reasons for these choices. Self-confidence and excellent athletic ability are the internal and external reasons, respectively. Enrollment is because teaching seems easy and is related to lack of interest. The learning motivation of students with different admission methods is similar, but the intrinsic motivation of girls is higher than that of boys, and the learning motivation of third-grade students is lower than that of other grades [11]. This study aims to explore how service-learning programs shape the cultural competencies of preservice teachers. Questionnaires were used to assess changes in students' cultural competencies. Reflective journals and interviews are qualitative data sources used to identify important factors in service-learning programs that lead to reflections on the role of cultural competencies in teaching and learning. The research results show that the cultural competence of college students has changed [12]. Physical education in Australian universities has always been a single field of teacher education, but in the past 20 years, it has involved many disciplines related to human movement research, leisure, and sports science. Love sports and sports leisure industry and take a new career path. With the popularization of higher education knowledge and the change of social organization, school education, especially high school education, came into being. With the rapid development and reform of information organization in colleges and universities, physical education has become the basic course of higher education. By analyzing the current policies and practices of physical education in colleges and universities, this paper puts forward some ideas for the future [13]. To explore the relationship between communication skills and levels of self-efficacy in physical education teacher candidates, in this study, random sampling was used to select samples. In the current study, the "Teacher Competency Expectation Inventory" (TCEI) and the personal information form based on the teacher competency indicators in the Higher Education Commission/World Bank National Education Development Program were used as data collection tools [14]. This paper summarizes the research on the socialization of physical education teachers. Many previous studies have mentioned the

prominent position of coaching orientation among new recruits; however, it has been suggested that new recruits and experienced teachers show a shift to teaching orientation. This change has triggered a new focus on the socialization of physical education teachers. However, the research since then has not been integrated. Therefore, the purpose of this study is to explore to what extent does the research on the socialization of physical education teachers record the changes in the nature of socialization; why this happens; and the enlightenment to schools and physical education. On the basis of the analysis, some suggestions for future research are put forward [15].

2. Literacy Evaluation under Grey Relational

2.1. Selection of Indicators for Teaching Literacy Evaluation. The evaluation of teachers' literacy largely depends on the evaluation of teachers' teaching level. Teacher evaluation has many contents, complex tasks, and high requirements. How to properly measure educational evaluation, transform qualitative indicators into quantitative indicators, and visually present the results of objective evaluation is the key to avoiding human factors as much as possible and giving full play to evaluation, fairness, and justice. Therefore, the selection of evaluation indicators should cover all aspects of evaluating teachers' teaching ability. Some of the criteria for assessing teachers' teaching ability are questioned based on the scientific principles, methods, procedures, and variables that should be followed in developing systems models. To further ensure the validity of the measures used, we revised the initial design measures by developing questionnaires and qualitative research methods to obtain the final analytical framework for the measures of teachers' teaching skills (see Figure 1).

2.2. Teacher Literacy Evaluation Process. Improve the level of teaching management and teaching talents in colleges and universities, and improve teachers' teaching skills, scientific research ability, teacher quality, and other indicators. Teachers better understand their own strengths and weaknesses, learn from each other about the strengths and weaknesses of their respective practices, and work together to support learning and development, but the first method and method of evaluation is to fill out the student and teacher evaluation form. The main purpose of evaluation is to evaluate teachers' professional titles and economic interests. This method often only describes one aspect of teachers' work, lacks depth and objectivity, and cannot fully evaluate teachers' work. With the rise of information science and the continuous development of communication technology, the management of the education system is gradually informed. If such a large amount of assessment information can be used for comprehensive assessment of teachers' competence through scientific data collection methods, the assessment of human factors can be excluded, the uncertainty of assessment can be reduced, and the assessment results can provide honest and very accurate insight, which is essential for school management, teacher long-term development, and improving teacher education. Due to the insurmountable problems of the classical complex evaluation method based on fuzzy transformation, in the process of using the objective function, all indicators are considered equally, and the relationship between the severity of each indicator factor is not considered, so the objective, reasonable, and easy evaluation work cannot be guaranteed. Technical realization elements: The purpose of the present invention is to overcome the deficiencies existing in the above-mentioned prior art, and to provide a method and system for evaluating teacher quality, which solves the problem that in the prior art; the indicators for teacher evaluation are not discriminated; and the importance of each indicator factor is not considered. Relationship, resulting in the lack of objective rationality of the evaluation work, and the influence of human factors is large. In order to achieve the above object, in the first aspect, the present invention provides a teacher quality evaluation method, which includes the following steps: Step 1: Collect multidimensional data samples of teachers, and establish a source data matrix. Step 2: Use the maximum value normalization processing method to standardize the source data matrix to obtain a standard data matrix. Step 3: Determine the weight coefficient of the evaluation factor according to the information entropy, and calculate the weight vector from the standard data matrix. Step 4: Perform clustering processing on the teacher set, and first use the fuzzy relationship. The transitive closure method roughly classifies all data samples and then performs precise classification based on the approximate classification. The process is shown in Figure 2.

2.3. Grey Relational Model. Grey correlation analysis is a multifactor statistical method and an important part of grey system theory. Compared with the traditional multifactor statistical method (regression analysis and difference analysis), it requires low sample size, and the calculated results will be consistent with the qualitative analysis results, so it should be divided into broad ones. Its basic idea is to judge the strength, order, and order of the relationship between factors by calculating the grey correlation degree between the main cause sequence and each cause sequence. The more grey correlation between the main cause sequence and the main cause sequence, the closer their relationship, and the more influence the main cause sequence has on the main cause sequence, and vice versa.

3. Grey Relational Analysis Model

3.1. Basic Steps of Grey Relational Analysis Model. The first thing to do is to introduce the reference sequence X^0 affecting the characteristics of the system. The data sequence reflecting the behavior characteristics of the system is the reference sequence as follows:

$$X_0 = \{X_0(1), X_0(2), \cdots, X_0(n)\}. \quad (1)$$

The data series composed of factors affecting the behavior of the system is as follows:

$$X_1 = \{X_1(1), X_1(2), \cdots, X_1(n)\}, \quad (2)$$

$$\cdots\cdots$$

$$X_m = \{X_m(1), X_m(2), \cdots, X_m(n)\}. \quad (3)$$

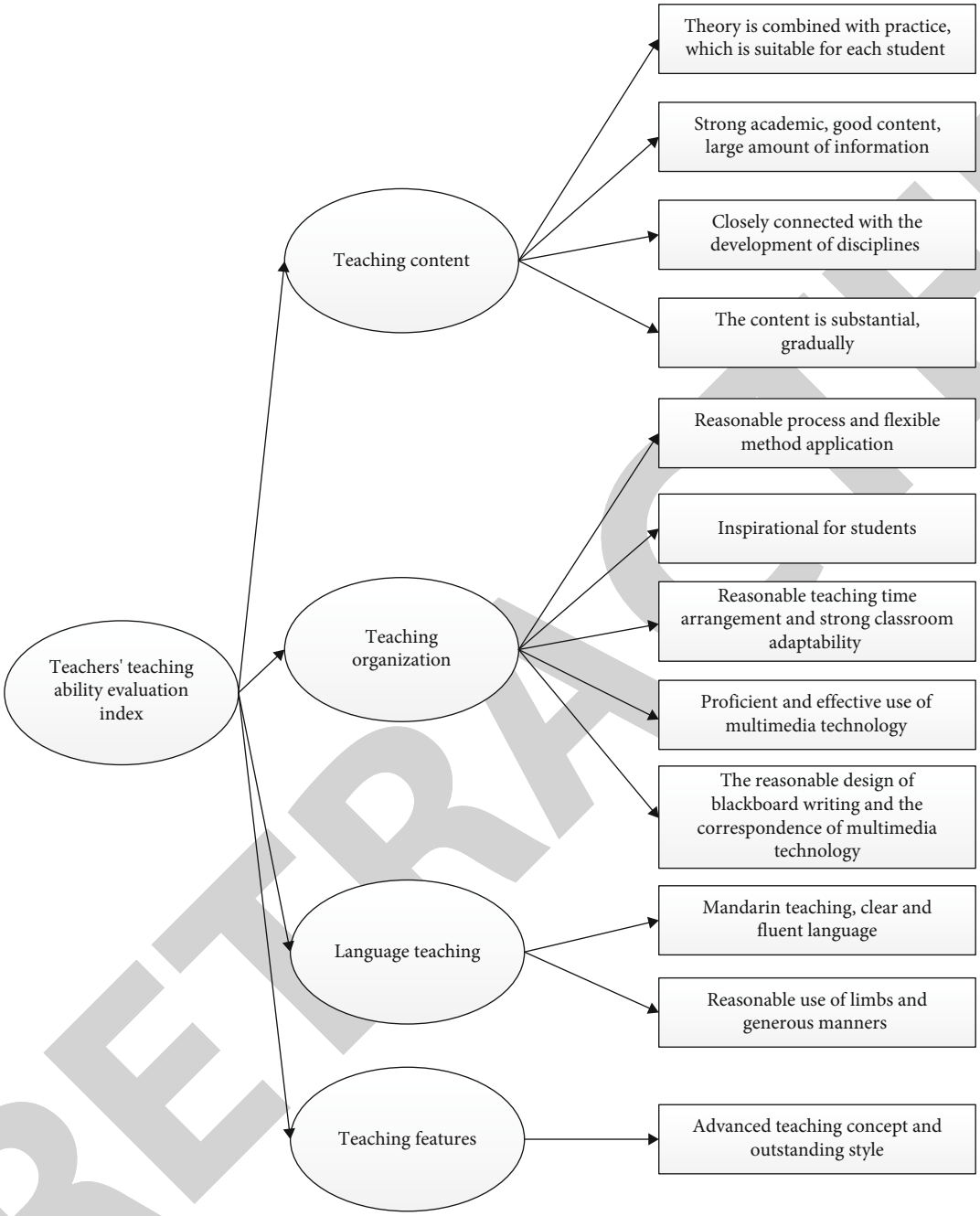

Figure 1: Teachers' teaching quality evaluation index.

Step 1: Find the initial value image of each sequence (after dimensionalization), and set

$$X' = \frac{X_i}{X_i(1)} = \left\{X_i'(1), X_i'(2), \cdots, X_i'(n)\right\}, \quad (4)$$

where $i = 0, 1, 2, \cdots, m$ gets:

$$X_0', X_1', \cdots, X_m'. \quad (5)$$

Step 3: Solve X_0 and X_i.

Record as

$$\Delta_i(k) = \left|X_0'(k) - X_i'(k)\right|,$$
$$\Delta_i = (\Delta_i(1), \Delta_i(2), \cdots, \Delta_i(n))i = 1, 2, \cdots, m\,; k = 1, 2, .., n. \quad (6)$$

The fourth step is to find the maximum and minimum values of $\Delta_i(k) = |X_0'(k) - X_i'(k)|$. They are recorded as

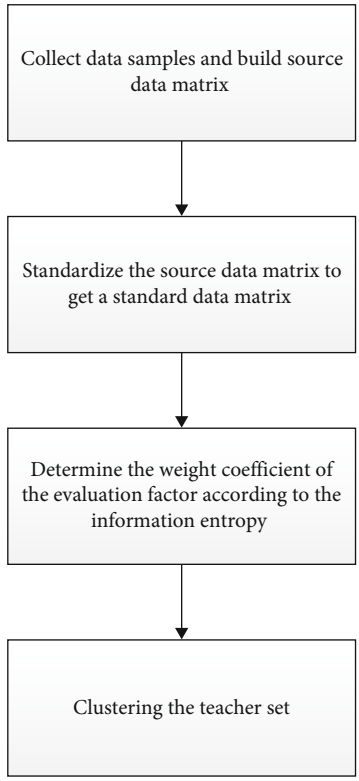

Figure 2: Teacher literacy evaluation process.

$$\Delta_{\min} = {}^{i\min k\min}\Delta_i(k),$$
$$\Delta_{\max} = {}^{i\max k\max}\Delta_i(k). \tag{7}$$

The fifth step is to find the correlation coefficient $\xi_i(k)$:

$$\Delta_{\min} + p\Delta_{\max},$$
$$\xi_{0i}(k) = \Delta i(k) + p\Delta \max, \tag{8}$$

where P is the resolution coefficient, $0 < P < 1$, and generally $P = 0.5$.

The sixth step is to find the correlation degree

$$\gamma_{0i} = {}^{1/n}\sum_{k=1}^{n} \xi_{0i}(k). \tag{9}$$

According to the size of γ_{0i}, distinguish the degree of association. If the value is larger, the degree of association is greater, and vice versa.

3.2. Grey Correlation Analysis Model Based on Point Correlation Coefficient. The main models of grey relational analysis are usually based on the degree of similarity. Deng's grey correlation analysis model illustrates this method. For $X_1 = (x_1(1), x_1(2), \cdots, x_1(n))$, it is the sequence of system behavior characteristics.

$$X_m = (x_m(1), x_m(2), \cdots, x_m(n)). \tag{10}$$

For the case of correlation factor sequence, the point correlation coefficient $\gamma(x_1(k), x_i(k))$ is defined

$$\gamma(x_1(k), x_i(k)) = \frac{\min\limits_i \min\limits_k |x_1(k) - x_i(k)| + \xi_{\max}\max\limits_i \max\limits_k |x_1(k) - x_i(k)|}{|x_1(k) - x_i(k)| + \xi_{\max}\max\limits_i \max\limits_k |x_1(k) - x_i(k)|}. \tag{11}$$

And the grey correlation degree $\gamma(X_1, X_i)$ between $X_i (i = 1, 2, \cdots, m)$ and X_1:

$$\gamma(X_1, X_i) = \frac{1}{n}\sum_{k=1}^{n} \gamma(x_1(k), x_i(k)). \tag{12}$$

Formula (12) is the calculation value of grey correlation degree of X_1, which is aimed at the grey correlation analysis model of point correlation. In the specific calculation, the original data can be processed according to two different methods: initial value change and average value change.

3.2.1. Generalized Grey Relational Analysis Model. At the same time, a class of generalized grey relational analysis model is also proposed. Let sequence

$$X_i = (x_i(1), x_i(2), \cdots, x_i(n)),$$
$$X_j = \left(x_j(1), x_j(2), \cdots, x_j(n)\right). \tag{13}$$

The starting point annihilation images are

$$X_i^0 = \left(x_i^0(1), x_i^0(2), \cdots, x_i^0(n)\right),$$
$$X_j^0 = \left(x_j^0(1), x_j^0(2), \cdots, x_j^0(n)\right). \tag{14}$$

Among them

$$X_i^0 = x_i(k) - x_i(1),$$
$$X_j^0 = x_j(k) - x_j(1), \tag{15}$$
$$k = 1, 2, \cdots, n.$$

The generalized grey relational analysis model constructed by this method has three different forms, which are shown in Formulas (16), (17), and (18).

The first expression method:

$$\varepsilon_{ij} = \frac{1 + |s_i| + |s_j|}{1 + |s_i| + |s_j| + |s_i - s_j|}, \tag{16}$$

where the meaning of letters in Formula (16) is shown in the following formula:

$$s_i = \int_1^n (X_i - x_i(1))\mathrm{d}t, s_j = \int_1^n \left(X_j - x_j(1)\right)\mathrm{d}t, s_i - s_j = \int_1^n \left(X_i^0 - X_j^0\right)\mathrm{d}t. \tag{17}$$

The second expression method:

$$\gamma_{ij} = \frac{1 + s_i' + s_j'}{1 + s_i' + s_j' + \left|s_i' - s_j'\right|}. \quad (18)$$

The third expression method:

$$\rho_{ij} = \theta\varepsilon_{ij} + (1 - \theta)\gamma_{ij}. \quad (19)$$

where $\theta \in [0, 1]$.

In Formula (16), the basic grey absolute relational analysis model can be used to analyze the relationship between absolute quantities of sequences, and in Formula (18), the grey relative relational analysis model based on the grey absolute relational analysis model and initial value transformation is mainly used to analyze the relationship between the change rate of sequences relative to the starting point. Formula (18) is to change the initial value of X_i first, and then, calculate the grey absolute correlation degree of X_i' after transformation.

4. Evaluation Index System of Physical Education Teachers' Literacy

4.1. Evaluation of Physical Education Teachers' Multifaceted Literacy

4.1.1. Gender Structure. There are differences in gender ratio in physical education teachers' literacy. The gender structure of physical education teachers reflects the absolute number of men and women in physical education teachers and its relationship with the total number of groups. There are great differences between men and women. It not only refers to the physical differences between men and women, but also refers to the huge gap between men and women in terms of thinking mode. If the share distribution of university teachers is more uniform, it can better supplement and support the development of teaching. In the profession of physical education teachers, male teachers have many advantages in physical condition and physical quality, so physical education teachers are mostly male, and there is an unequal gender balance between men and women. The survey found that the ratio of male to female teachers is roughly 79% for male teachers and 21% for female teachers. At the same time, we also made a survey on the influence of five male and female physical education teachers on teaching satisfaction, as shown in the figure.

Figure 3 shows the influence of each of the five male and female physical education teachers on the teaching quality in terms of gender. The evaluation of teachers' literacy is multifaceted, and the difference between men and women will also affect. On the quality of physical education, the average satisfaction of female teachers is about 0.8, while the average satisfaction of male teachers is slightly higher than that of female teachers, reaching 0.87. Because of subjects, male teachers have better physical quality, so their satisfaction is also better. We also calculate the accuracy of the experimental data through the grey relational degree model, and get the satisfaction of each time, as shown by the thick line in the figure, and the linear summary of the grey relational degree for this survey is shown by the thin line in the figure. The average accuracy is 0.88.

4.1.2. Age Structure. Age is a sign of natural aging and an uncontrollable part of people. The age structure of physical education teachers refers to the proportion of each age group in the whole. For teachers of ordinary subjects, the older they are, the richer their teaching experience is, but physical education teachers are quite different. Although teaching experience will increase, physical education is different from others, and teachers need to lead by example to demonstrate actions, which lead to the inability of older teachers. Young teachers are more suitable for physical education teachers, and their youthful vitality will make students participate more actively. The distribution and teaching quality of physical education teachers of all ages are investigated, as shown in Figure 4.

Figure 4 shows the age structure and teaching quality of physical education teachers. We can see that the quality of teaching varies from age to age. In the survey, the teaching quality of physical education teachers aged 25-30 reached nearly 90%, followed by teachers aged 30-35, and the number of teachers in these two ages was also the largest. Teachers in these two ages were not only in good health, but also had a lot of experience in teaching. A good combination of the two is also of obvious help to teaching.

4.1.3. Educational Background Structure. Postgraduates and doctors are very important in physical education. It is very important for the faculty and staff working in colleges and universities and has a far-reaching impact on personal education and other abilities. With the increase of the number of students in China, the number of undergraduate, master's, and doctoral students has increased, and higher education has shifted from elite to mass. Some schools have national physical education class, and the academic qualifications of coaches and judges of the national team are lowered, but the academic qualifications of teachers are also slowly rising. Through the survey found that the proportion of the structure of education in physical education teachers, the quality of these teachers also carried out a survey found that there are some differences, as shown in the following figure.

Figure 5 is a summary of data introducing the educational background structure and teachers' literacy. For the distribution of educational background, with the increasing requirements of teachers, the educational background requirements are also increasing. In the survey of physical education teachers, graduate students are in the majority, among which master students are the most, and doctoral students account for less among physical education teachers because of the small overall number. For the literacy score under the influence of educational background, we have made a survey on various groups of people. The external literacy of doctoral students is the highest, followed by master's students, undergraduates and junior college students are the lowest, but there is not much difference in external literacy among them. The main gap lies in the internal accomplishment, and the higher the educational background, the more knowledge you learn. Knowledge is rich inside. Therefore, the gap between junior

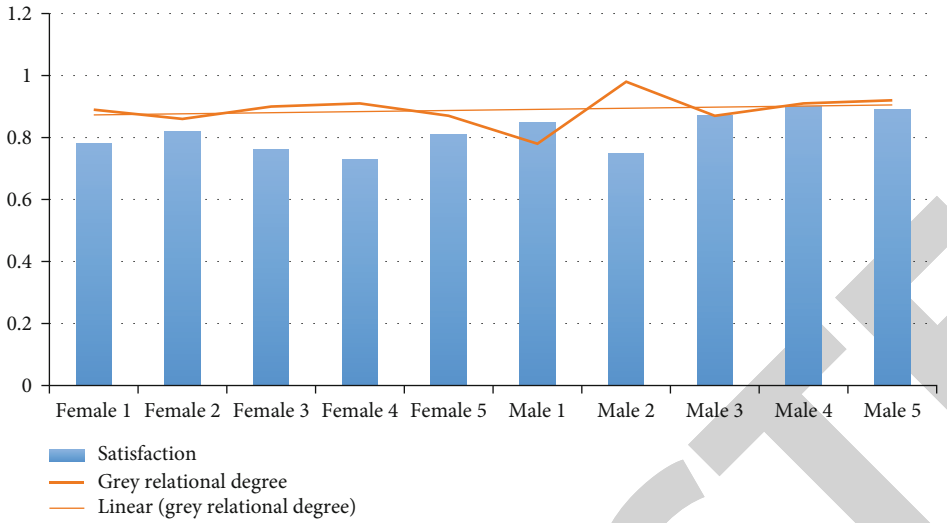

Figure 3: Investigation on gender satisfaction of physical education teachers to teaching.

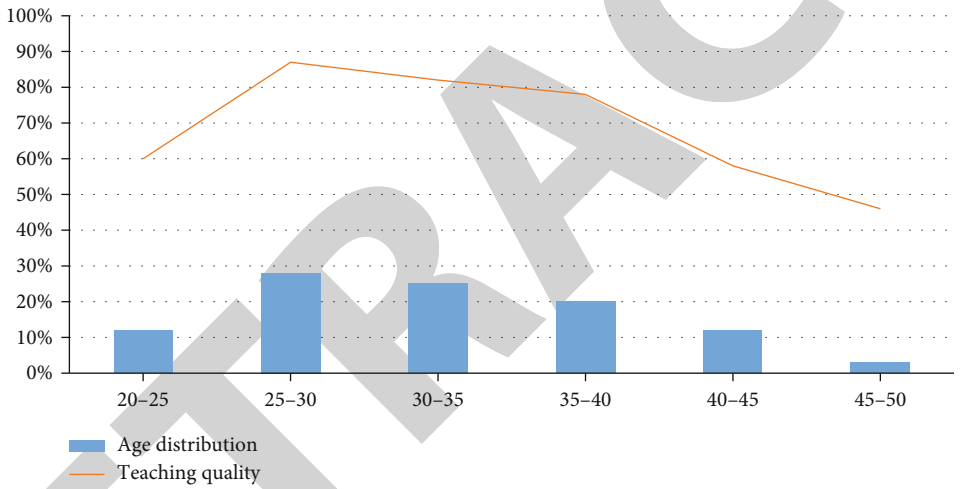

Figure 4: Age structure of physical education teachers and teaching quality.

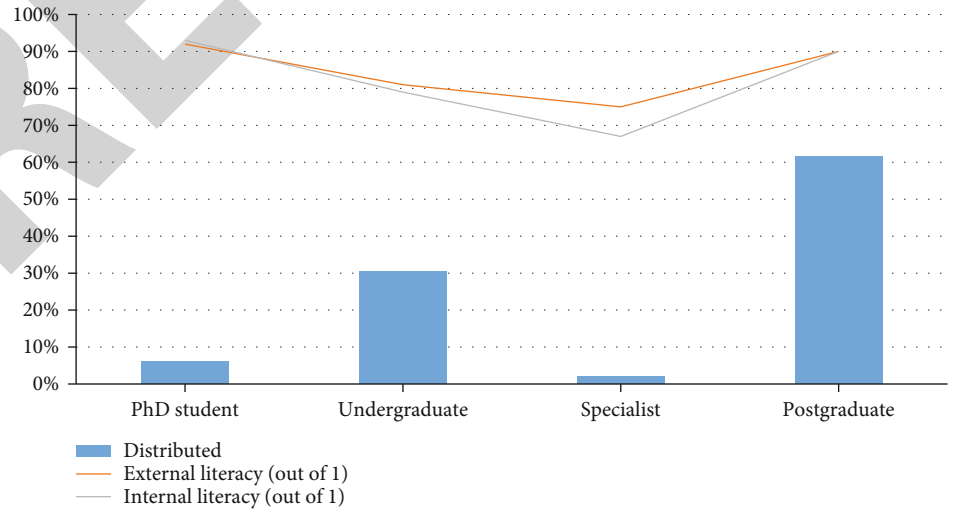

Figure 5: Educational background structure and teacher literacy.

college students and graduate students is obvious, but they can also improve their internal literacy through other studies.

Figure 5 illustrates the educational background structure and teachers' literacy among the respondents. As shown in the figure, we can clearly see the distribution of educational background structure among the teachers participating in the survey, with graduate students accounting for 62% and doctoral students accounting for 6%. Junior college is at least 2%. There are many influences on teachers' quality. Here, the total scores of internal literacy and external literacy are 1. There is little difference between internal literacy and external literacy in graduate students, but for junior colleges, because what they learn is only different, there is a big gap between teachers' personal internal literacy.

4.2. Selection and Establishment of Evaluation Index of Physical Education Teachers' Comprehensive Quality. Physical education teachers need not only the qualities of ordinary teachers, but also the physical qualities of physical education. Combined with the suggestions of experts, we classify the known comprehensive qualities, which are roughly divided into three parts: professional basic qualities, professional standard qualities, and marginal qualities.

4.2.1. Selection of Evaluation Indicators. The personal image, ability, knowledge, and skills embodied by college physical education teachers in college physical education play an exemplary role for students. Therefore, this study conducted an in-depth discussion with the instructor after personally reviewing the learning materials. In the form of interviews, we frequently reflect and solicit expert opinions. The first-level indicators of comprehensive teacher knowledge are divided into professional teachers' basic knowledge, practical teachers' knowledge, and neighborhood teachers' knowledge. In the process of making and completing the expert questionnaire and teacher questionnaire, we solicited the views of experts and teachers on the distribution of indicators, and obtained the following data.

According to Table 1, we can know that four people agree with the results of expert questionnaire survey, two agree with it, and no one opposes it. In the teacher questionnaire, 6 people agree very much, and 37 people agree relatively. Therefore, it can be seen that the questionnaire is effective, and no one disagrees with the classification, so the second indicator can be subdivided on this basis.

When classifying the secondary indicators, the research on the basic professional quality of college physical education teachers thinks that it should be composed of four parts: physical education quality, psychological quality, professional skills, and knowledge structure, which are the most basic qualities in physical education. 16.67% of experts strongly agree, 66.66% agree, and 16.67% generally agree. According to the results of the questionnaire survey, 16.28% of professors strongly agree, and 69.77% of teachers and 13.95% of teachers generally agree. It may be useful to divide the basic knowledge of using first-class symbols into four categories: physical knowledge, conceptual knowledge, functional skills, and organizational knowledge.

In terms of professional quality of college teachers, this course should include three aspects: skills, technical training, and research ability. 33.33% of the experts agreed, and 66.67% of the experts agreed. According to the results of teachers' questions and the opinions of experts' questions, 16.28% of the experts agreed, 79.07% of the teachers agreed, and another 4.65% of the teachers reached the average level. Admittedly, it is necessary to divide vocational training into the above four intermediate indicators. Nowadays, society is slowly entering the era of everyone's participation, so teachers' literacy has become an important part of teacher education. 66.67% of the experts agreed, and 13.33% of the experts generally agreed that competitiveness should not be included in teachers' marginal education according to the changes of experts' questionnaires, so this product was excluded from teachers' survey, 18.60% of teachers agreed, 74.42% of teachers agreed, and 6.98% of teachers' reports were average. It can be seen that the acceptance of marginal indicators to teachers is divided into the above three parts. By modifying expert questions and teachers' questionnaire feedback, the first and second level indicators of all good performance of physical education teachers used in this study questionnaire are formulated.

4.2.2. Evaluation Established. After the above analysis and investigation, we can accurately establish the evaluation index so as to make it more convenient to evaluate the quality of physical education teachers. It mainly determines the first-level evaluation standards, such as professional standard literacy, professional basic literacy, and teacher marginal literacy. After evaluating the first-level indicators, it evaluates the second-level indicators more specifically. Professional standard literacy includes teaching ability, training ability, and scientific research ability. Professional basic literacy includes physical literacy, psychological literacy, professional skills, and knowledge structure, while teachers' marginal literacy includes professional ethics, information literacy, humanistic literacy, and competition adjudication ability. After the evaluation index is determined, the evaluation process and steps need to be determined, as shown in the following figure 6:

4.3. Teachers' Literacy under Grey Correlation Degree. Grey relational model is a model that expresses the degree of correlation with it. For teacher literacy evaluation, it is not only to express the degree of correlation between teacher literacy evaluation index and teacher literacy. Above, we described various indicators for evaluating teachers' literacy. Grey relational analysis is an effective method to study the relational degree of various factors in the system. Its basic idea is to determine the tightness of the connection between sequences according to the similarity of geometric shapes of behavioral sequence curves. It is realized by calculating the grey correlation degree. For the comprehensive evaluation of teachers' ability and quality, this paper analyzes the commonly used teacher evaluation indicators and puts forward the data comparison based on grey relational analysis to determine their correlation degree. First, we investigated the influence of teachers' age, educational background, and gender on teachers' literacy. The correlation degree is shown in the following figure.

Table 1: Statistics of questionnaire survey results for the establishment of first-level indicators.

	Total number	Very agreeable	Compare and agree	Agree	Compare disagreement	Deeply disagree
Expert questionnaire	6	0	4	2	0	0
Teacher questionnaire	43	6	37	0	0	0

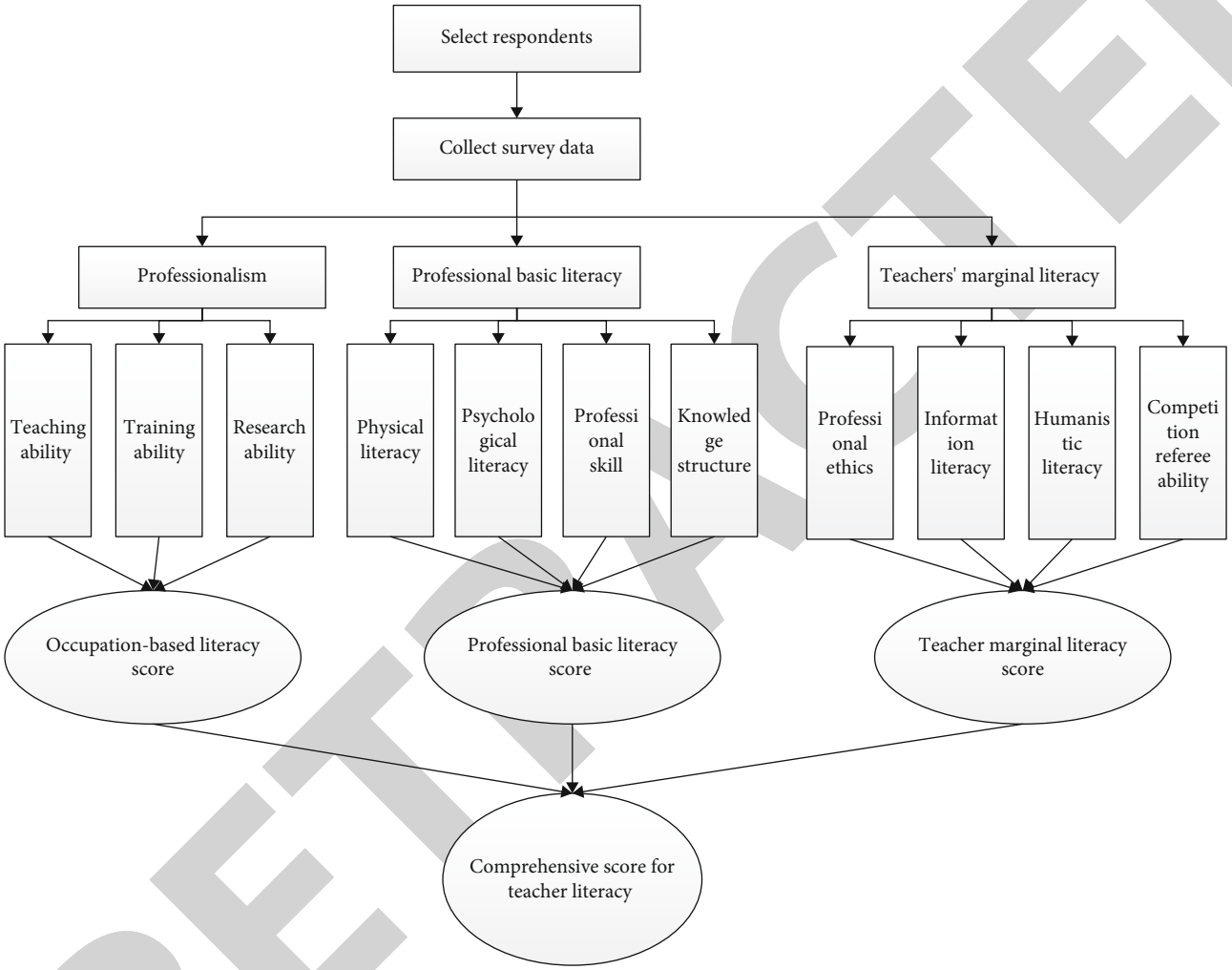

Figure 6: Specific process of teacher literacy evaluation.

Figure 7 illustrates the relationship between the basic information of physical education teachers and the grey correlation degree; after many experiments, we can get the grey correlation degree of the curve shown in the figure in each experiment; and we can get the relationship degree between this item and physical education teachers' literacy by averaging it. The dotted line in the figure is the average value of data obtained after many experiments, which can show the relationship between this index and grey relational degree, and can see the degree of relationship with teachers' literacy more intuitively. The correlation between teacher literacy and education is the highest, followed by age, and the weakest correlation is gender.

In Figure 7, we have conducted an experimental study on the grey correlation between the basic information of physical education teachers and teachers' literacy and obtained data. For age, gender and educational background, the grey correlation with teachers' literacy is not very high, and the educational background is slightly higher among these three, with an average value of about 0.68. The average correlation degree of age is 0.64. The average grey correlation degree of gender is 0.56. It shows that the correlation degree of educational background on teachers' literacy is slightly higher than the other two. Then, we carry out grey analysis experiment on the first-level index of teacher literacy evaluation and get the data as shown in the figure.

Figure 8 is the correlation analysis of the first-level indicators to teachers' literacy. By comparing the three first-level indicators, it can be seen that the professional basic literacy

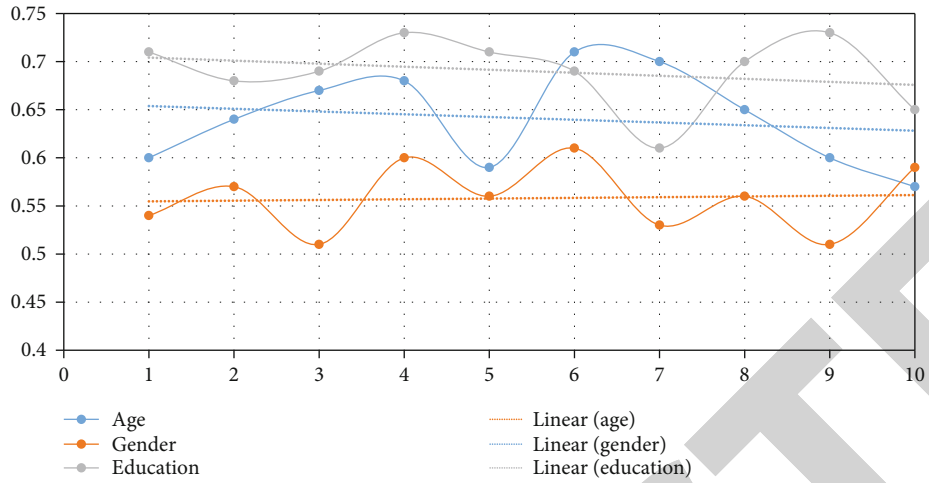

Figure 7: Grey correlation degree between basic information and teacher literacy.

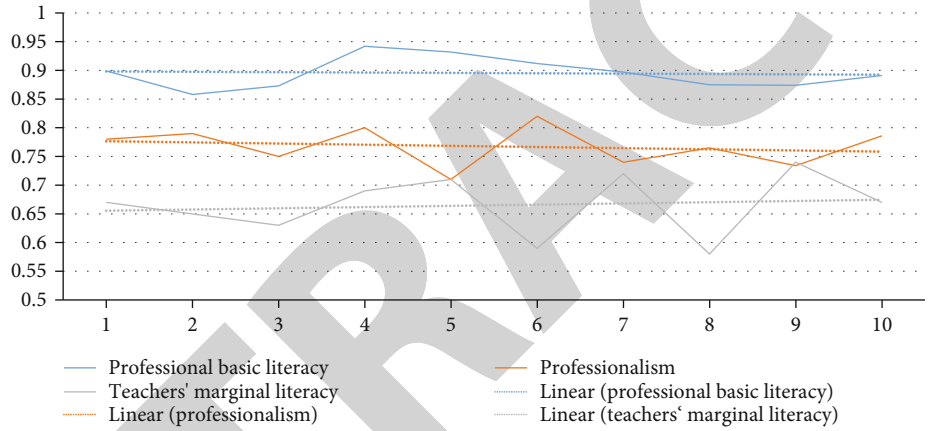

Figure 8: Grey correlation degree of first-class index.

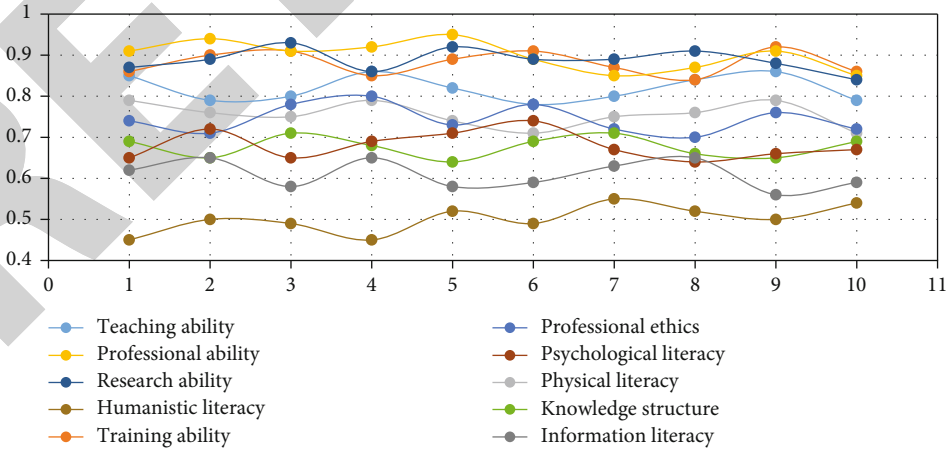

Figure 9: Grey correlation degree of secondary indicators.

has the highest correlation with teachers' literacy, while the grey correlation of teachers' marginal literacy is the lowest, and its correlation degree is also the lowest.

Figure 9 is the grey correlation degree of factors affecting physical education teachers' literacy. This figure shows the influence of evaluation factors on physical education teachers'

Table 2: Statistics of questionnaire survey results for establishing secondary indicators.

Indicators	Crowd	Total number	Very agreeable	Agree	General	Disagree	Deeply disagree
Professional basic accomplishment	Expert questionnaire	6	1	4	1	0	0
	Teacher questionnaire	43	7	30	6	0	0
Professional standard accomplishment	Expert questionnaire	6	2	4	0	0	0
	Teacher questionnaire	43	7	34	2	0	0
Marginal accomplishment of teachers	Expert questionnaire	6	0	4	2	0	0
	Teacher questionnaire	43	8	32	3	0	0

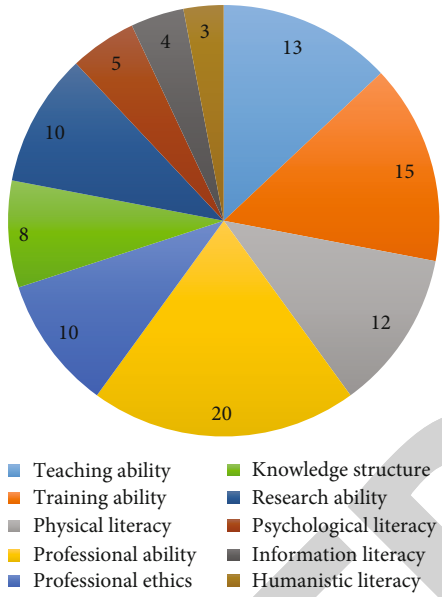

Figure 10: Comprehensive scoring system.

literacy. This paper mainly investigates six aspects: teaching ability, training ability, physical literacy, professional ability, professional ethics, and knowledge structure. We have conducted many experiments to ensure the accuracy of the experiment. We trace the data calculated from each experiment in Figure 9 and then connect them into a line. A dotted line in the figure is the linear relationship value, which clearly shows the selected evaluation index of physical education teachers' literacy.

Figure 9 studies the grey correlation degree of various factors affecting physical education teachers' literacy in detail. From Table 2, we can see that the grey correlation degree of professional ability is the highest among the evaluation factors, reaching the average value of 0.9. It shows that this evaluation factor is the most important for physical education teachers' literacy, followed by training ability, and training is very important in sports, so the grey correlation degree of teachers' training ability is also very high. The lowest is humanistic quality, with an average value of only 0.5. The grey correlation degree is low.

4.4. Comprehensive Score of Teacher Literacy. In the analysis and research of teachers' literacy, we determine the correlation degree of each evaluation index through grey correlation model. Under the analysis of the first and second indicators, the correlation degree of professional professionalism is higher, so his score accounts for the highest proportion, followed by professional standard literacy, and finally by teachers' marginal literacy. In the score, the score proportion will be divided according to the correlation degree, and then, the score will be divided according to the correlation degree of secondary indicators. The final score of 100 is as follows:

For Figure 10, which shows the proportion of comprehensive scores in teachers' literacy, the final comprehensive scores can be obtained by multiplying them by the proportion according to various indicators.

5. Conclusion

This paper makes a detailed introduction and research on the evaluation index and application of physical education teachers' literacy under the grey relational model. With the development of society, people pay more attention to their health, and the literacy of physical education teachers is particularly important. As for the evaluation index and application of physical education teachers' literacy, we analyze the basic conditions of physical education teachers themselves, marginal literacy of teachers, professional standard literacy, and professional basic literacy, and analyze the grey correlation degree of these aspects for physical education teachers' literacy. Also, the grey correlation degree shows that teachers' professional ability and teachers' accomplishment have the greatest correlation degree and also introduce the calculation of grey correlation degree in detail.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

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Retraction

Retracted: Research on Collaborative Innovation of Supply-Side Reform of University Ideological and Political Education Based on Intelligent Big Data Information Fusion

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] X. Li, Z. Li, and X. Xia, "Research on Collaborative Innovation of Supply-Side Reform of University Ideological and Political Education Based on Intelligent Big Data Information Fusion," *Journal of Sensors*, vol. 2022, Article ID 2557617, 11 pages, 2022.

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Research Article

Research on Collaborative Innovation of Supply-Side Reform of University Ideological and Political Education Based on Intelligent Big Data Information Fusion

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The times are changing with each passing day, and the traditional ideological and political education cannot adapt to the information age. Schools overemphasize theory, weaken the implementation of practice, ignore the needs of students, and lack electronic equipment to assist learning. All these factors make ideological and political education in colleges and universities stay in a superficial form and do not really lead students to study deeply. Innovation introduces supply-side vision, reforms educational theory structurally, and accelerates the transformation of classroom style. Let teachers and students leave the shackles of the classroom, learn from various sources of knowledge, and carry out personalized learning from their own areas of interest. The results show that (1) after data fusion, the credibility of ideological and political knowledge is 91%, which is better than other methods. (2) The knowledge base constructed by the laboratory meets the standards of colleges and universities, and its quality passes the standard, but its timeliness is slightly poor, and the test result is about 85%. (3) Learning interest model can push personalized knowledge according to students' characteristics. (4) In the actual scene, students' ideological and political education shows a benign development trend. The results of this study are quite satisfactory, which verifies the practicability and effectiveness of the proposed method and obtains feasible results.

1. Introduction

In recent years, global Informa ionization has been basically realized, and earth-shaking changes have taken place in human work, study, and life. The efficient and convenient scientific and technological strength brought by this change has liberated some simple mechanical work for mankind, but it has not perfectly integrated all walks of life with the existing technology, which is undoubtedly a waste of resources. Taking ideological and political education in the education sector as an example, colleges and universities still adopt backward pure theoretical methods to instill students in this related classroom, which is divorced from the realistic basis, and at the same time, there are problems of incoordination and imbalance with students' ideological needs, which cannot achieve the effect of educating people in all directions. Colleges and universities need to combine innovative ideas, make effective use of intelligent equipment, integrate various sources of information, build an educational reform model relying on students as the main body, and greatly expand the direction and space of practice.

Questionnaire survey and field interview classroom teaching, from the perspective of "supply side," find out the strategic policy to solve the phenomenon of "low-headed people" [1]. Discuss the imbalance between content, mode, carrier, and actual demand under supply-side thinking [2]. Judge and evaluate the results of collected knowledge, organize and fuse fragmented information, and build an applicable network knowledge framework [3]. From the perspective of complex systems and cross-domains, the processing architecture of granular computing and R&D management control is proposed, which can be used for intelligent modeling of data fusion problems [4]. In order to discover valuable cross-media intelligence, data synthesis,

induction, and filtering are carried out through the framework of deep cognitive neural network [5]. Referring to the process of building an intelligent university information management service system, ETL, data warehouse modeling, and other technologies are used [6]. Examine a variety of network information challenges from a three-dimensional perspective, and realize the high integration and two-way interaction between big data and ideological and political education [7]. According to the ideological needs of college students, this paper comprehensively analyzes the contradiction between supply and demand and innovative development of ideological and political education in colleges and universities [8]. In view of the isolated island phenomenon of multisource learning information, NoSQL technology is used to build a data sharing system to solve the problem of heterogeneous fusion [9]. Because RBM under mega data has the problem of slow model training, the design of MapReduce framework based on Hadoop can effectively accelerate large-scale training [10]. Based on data collection and processing, the metadata relational mapping table is constructed, and different educational information is intelligently fused with Protege software and semantic ontology [11]. Combining concept drift detection algorithm with unsupervised reverse verification algorithm, knowledge from various sources is efficiently fused [12]. Least squares algorithm and D-S evidence theory method are introduced in sink node and monitoring terminal, respectively [13]. Analyze the significance of knowledge service to meet deep information needs and realize multimodal innovation [14]. Information complementary mechanism improves the accuracy of data analysis, accurately depicts learning subjects and situations, and intelligently restores the whole picture of teaching [15].

The above-mentioned literature provides a reference method and ideas for the experiment of this paper and provides a strong theoretical and data support. Comply with the trend of the times, innovate and develop the "online + offline" learning mode from the new perspective of supply-side reform theory, and realize self-reflection and reform. Knowledge integration is carried out for information from various sources on the network, which enhances the credibility, availability, and sharing of knowledge and provides a solid foundation for the subsequent development of intelligent classroom. In addition, by constructing the online learning model of learners, teachers can find out the key points and learning situations that students are interested in, and feedback the results to the classroom teaching content, so as to carry out ideological and political education activities smoothly.

2. Theoretical Basis

2.1. Ideological and Political Education and Supply-Side Reform in Colleges and Universities. Ideological and political education in colleges and universities is a subsystem of the whole university. It can exist independently and is closely related to every student, teacher, parent, and society. We should not only achieve the purpose of educating people but also guide students' ideological education contents such as world outlook, outlook on life, and values. In addition to the classroom in school, ideological education should be infiltrated into all aspects of life. Because of its complexity and openness, the single and fault education mode is doomed to be wrong. Only by forming an orderly organizational structure, orderly and coordinated, can we achieve the most efficient overall educational purpose. Supply-side structural reform was first proposed in 2015 [16]. It was originally applied to the economic field, aiming at reducing the financing cost of enterprises and improving the level of social productivity. In order to obtain stable economic quality and quantity, this reform method starts from the supply point of view, adjusts the economic structure, corrects the unreasonable parts, makes the production factors reach the optimal allocation, and improves the flexibility, adaptability, and effectiveness of the supply structure, so as to meet the needs of people's daily life and improve people's quality of life from the source. The reason why this method is introduced as a new perspective to examine the ideological and political education in colleges and universities is that there is some objectivity and inevitability between this reform and ideological and political education in colleges and universities. They can further deepen the theoretical application in the process of collaborative innovation. Their contents are complementary [17], their operation mechanism is consistent [18], their basic logic is consistent, and their development dynamics [19] are similar, which can always adapt to the fluctuation of society and people's needs. Using the thinking of side supply to optimize the classroom structure should be guided by students' actual situation and actual needs and promote colleges and universities to reduce ineffective or inefficient knowledge output. Attach importance to the innovation of content and method, refuse the traditional "rote learning" form of learning, and flexibly adapt to the new development of new science and technology. In addition, educators' own knowledge reserve and ability to adapt to science and technology should be required, and they should be good at showing rich knowledge on the Internet to students and leading them to the correct ideological path. Strengthen the benign interaction between educators and students, and promote the growth of students' thoughts in the process of effective dialogue.

2.2. Knowledge Evaluation Method for Big Data. Because of the different data sources, there will be conflicts and inconsistencies in the knowledge obtained from the network. Before merging, it is necessary to find the real facts in the real world, that is, the truth value, through knowledge evaluation. Only correct knowledge can ensure that the knowledge base is not disturbed by wrong knowledge, some low-value data, and outdated or invalid information. Ensure the credibility and practicality of knowledge sources. The idea of using Bayesian model [20] to estimate is more traditional and mature. From a mathematical point of view, the Bayesian core algorithm can be defined as

$$P(B|A) = \frac{P(A|B)P(B)}{P(A)}. \quad (1)$$

First, formula (2) sets a set of knowledge to be evaluated. Formula (3) represents the observations obtained by the data source. Let the joint probability distribution of observed values be shown in formula (4). According to Bayesian theory, the posterior probability shown in formula (5) can be obtained. If we assume that the observed values are independent of each other, we can get formula (6). Finally, by bringing formula (6) into formula (5), we can get the posterior probability when k_i is true, that is, the correct knowledge we are looking for.

$$k = \{k_i | 1 \le i \le n\}, \tag{2}$$

$$S = \{S_j | 1 \le j \le m\}, \tag{3}$$

$$P(S) = P(S_1, S_2, \cdots, S_m), \tag{4}$$

$$P(k_i|S) = \frac{P(S|k_i) \cdot P(k_i)}{P(S)}, \tag{5}$$

$$P(S|k_i) = \prod_{j=1,m} P(S_j|k_i), \tag{6}$$

$$P(k_i|S) = \frac{\prod_{j=1,m} P(S_j|k_i) \cdot P(k_i)}{\sum_{j=1,n} \prod_{j=1,m} P(S_j|k_i) \cdot P(k_i)}. \tag{7}$$

Because of the limitations of Bayesian method, we need to satisfy the independence and predictable probability of knowledge, so we add two methods that can be used for knowledge evaluation. The local theory of classification is adopted and fuzzy integral is used to relax the limitations of the original Bayesian method. The graph model method is based on neural network, which transforms the original link prediction problem into matrix filling problem. The knowledge evaluation method based on fuzzy set theory [21] needs to meet the following basic conditions:

$$\begin{cases} g(\varnothing) = 0, \\ g(X) = 1, \end{cases} \tag{8}$$

$$\begin{cases} g(A) \le g(B), \\ A \subseteq B \text{ and } A, B \subseteq X, \end{cases} \tag{9}$$

$$\begin{cases} \lim g(A_i) = g(\lim A_i), \\ A_i \subseteq X, \end{cases} \tag{10}$$

where X represents the set. Where the Borel field is an empty set, g represents the measurement function, and $\{A_i\}$ represents the single-tone set sequence. An additional rule is added to solve the measurement problem by fuzzy measurement. On the basis of the above measurement, let $\lambda > -1$ get the value of formula (12) by solving. Set the blur density to $X = \{x_1, x_2, \cdots, x_N\}$, $g_i (i = 1, 2, \cdots, N)$.

$$\begin{cases} g(A \cup B) = g(A) + g(B) + \lambda g(A) g(B), \\ A \cap B = \varnothing, A, B \subseteq X, \end{cases} \tag{11}$$

$$\lambda + 1 = \prod_{i=1,N} (1 + \lambda g_i). \tag{12}$$

Fuzzy integral [22] is defined as follows.

$$\int_A h(x) \circ g(\cdot) = \sup_{0 \le \alpha \le 1} [\min(\alpha, g(A \cap a_\alpha))], \tag{13}$$

$$a_\alpha = \{x : h(x) \ge \alpha\}. \tag{14}$$

Graph model is also a popular method. Let the original knowledge base be a three-dimensional matrix [23], and calculate the low-rank decomposition. Then, use the standard MLP [24] to capture the interaction items.

$$\Pr(G(s, p, o) = 1) = \sigma\left(\sum_{k=1}^{K} u_{sk} \omega_{pk} v_{ok}\right), \tag{15}$$

$$\Pr(G(s, p, o) = 1) = \sigma\left(\beta^T f\left[A\left[u_s, w_p, v_o\right]\right]\right). \tag{16}$$

2.3. Theory Related to Ideological and Political Interest Model. According to the principle of supply side of ideological and political education, we cannot homogenize every student. As an independent individual, every student has his own preferences and excellence. Because of individual differences, everyone's interest in learning is different. Traditional classroom teaching is a one-to-many teaching mode. Because of the limited class hours and teaching tasks, teachers can only take care of most students' learning wishes and learning effects and cannot put forward effective learning methods for everyone. Therefore, constructing students' ideological and political interest model and pushing relevant courses and knowledge content according to interest can effectively make up for the shortcoming that offline classroom teachers cannot give detailed guidance. Teachers can also adjust the classroom structure more reasonably according to students' online learning and the reform principle of supply-side structure, subtract ineffective or unnecessary explanations, and spend this part of time on other more meaningful teaching activities to promote teacher-student interaction. Firstly, we construct a long-term learning interest model based on vector space model and express the interest vector and interest degree. The time decay factor [25] is introduced, and the time window is set to one week. More attention should be paid to learners' recent behavior, and short-term interest model should be established for learners.

$$\vec{t}_{u_i} = \left\{w_{u_i}^{t_1}, w_{u_i}^{t_2}, \cdots, w_{u_i}^{t_l}\right\}, \tag{17}$$

$$w_{u_i}^{t_j} = \frac{n_{u_i}^{t_j}}{\sum_{j=1}^{l} n_{u_i}^{t_j}}, \tag{18}$$

$$\vec{I}_n = (1 - \alpha) \vec{I}_{n-1} + \alpha \Delta \vec{I}. \tag{19}$$

TF-IDF is used to count the importance of words, which is convenient to judge the field of knowledge subject words.

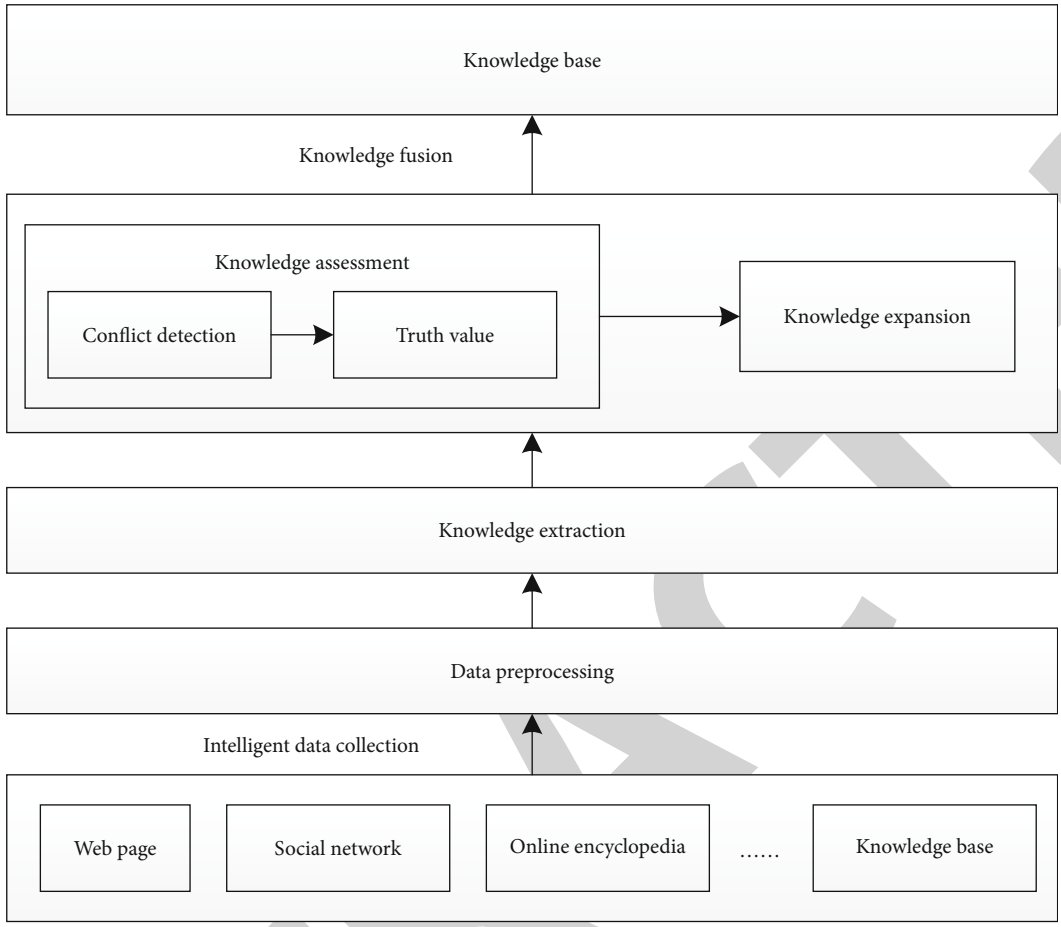


Figure 1: Knowledge information fusion framework.

The formulas for TF, IDF, and TF-IDF are as follows:

$$tf_{ij} = \frac{n_{ij}}{\sum_{k=0}^{m} n_{kj}}, \tag{20}$$

$$idf_j = \log \frac{N}{1 + n_j}, \tag{21}$$

$$\text{score} = tf_{ij} * idf_j. \tag{22}$$

3. Side Supply Intelligent Model and Application of Ideological and Political Information Fusion

3.1. Data Fusion Model. In addition to changing the source of classroom knowledge, in order to better promote the supply-side structural reform. We should grasp the educational theme of students, change the perspective of demand and supply, go deep into the perspective of students, and follow the general and special laws of educational development to make changes. The purpose of this section is not to obtain more and more contents related to political education, but to collect various data from different sources, mine knowledge that can be effectively related from massive fragmented data, and fuse the knowledge into a database, which is convenient for application in actual educational classroom scenes. According to the side supply theory, we need to exclude the content unrelated to ideological and political education and solve the information deviation brought by this part from the source. Therefore, data preprocessing before fusion is very important. For heterogeneous data, their formats are also different, so they should be treated by unified operations and represented in a standardized way. Through this framework, we can clearly see the whole process of how to integrate big data information: First, accurately identify the knowledge related to political and ideological education from the massive and complicated information on the network, and efficiently collect a large number of data from different sources or forms. After preprocessing the data into standard form, natural language processing technology is used to extract various elements of knowledge. After verifying the quality and credibility of these knowledge by using the knowledge evaluation module, the knowledge expansion module updates the knowledge and organizes and generates the knowledge base according to the type and order of knowledge after merging calculation, as shown in Figure 1:

3.2. Student Personalized Modeling. This section mainly uses the learning interest model to make personalized learning

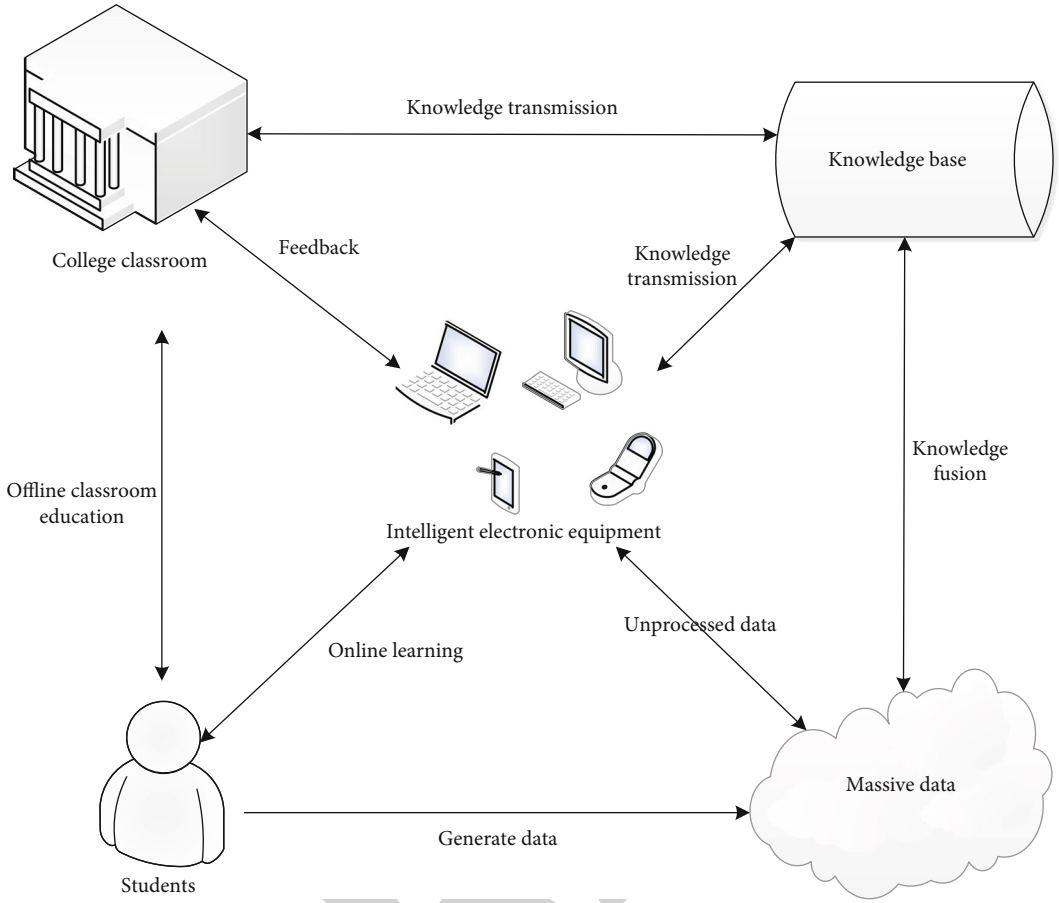


Figure 2: Application framework of reforming the new classroom model.

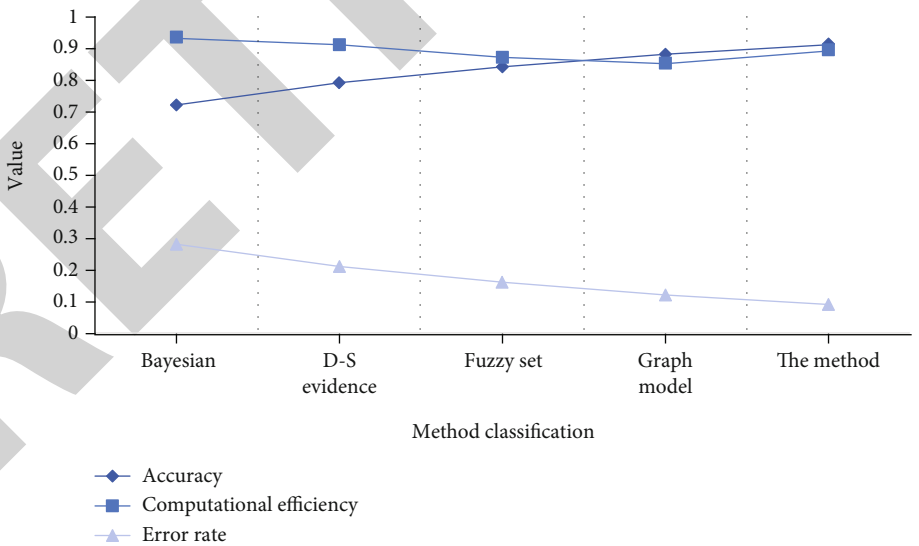


Figure 3: Comparison of evaluation methods.

recommendation. TF-IDF method can count the key vocabulary of students, so that the topic summary of the knowledge base system can be extracted to the knowledge field related to this ideological content. According to students' personal information, interest, and knowledge reserve, we should build a network of learning trust relationship and improve personalized curriculum formulation. Deeply understand the definition of cosine similarity and calculate

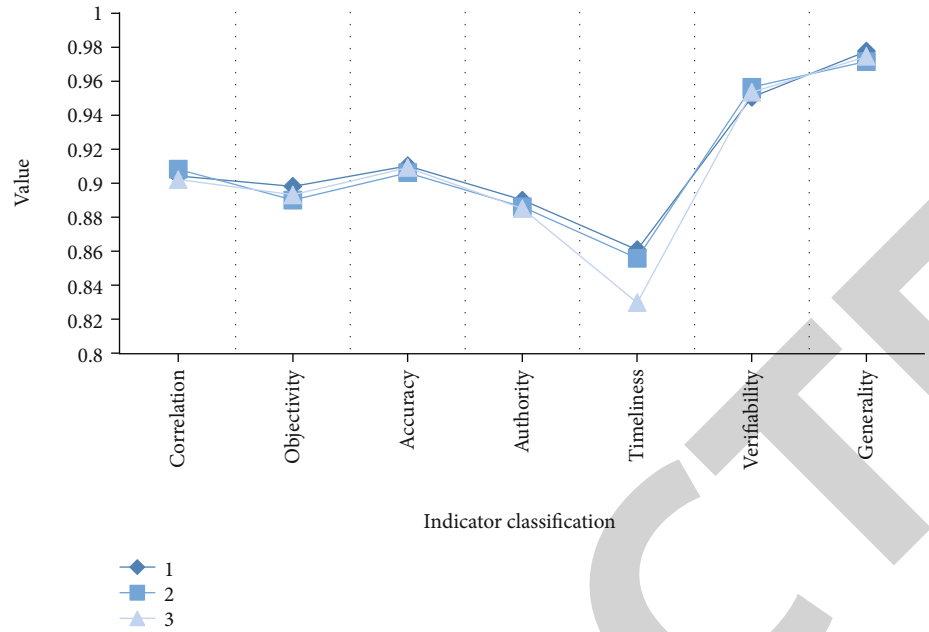


Figure 4: Evaluation of knowledge index.

students' interest similarity. Calculate the interesting knowledge topics, courses, and knowledge fields, respectively.

$$t\_\mathrm{sim}(u_i, u_j) = \frac{\vec{t}_{u_i} \cdot \vec{t}_{u_j}}{\left|\vec{t}_{u_i}\right|\left|\vec{t}_{u_j}\right|}, \tag{23}$$

$$c\_\mathrm{sim}(u_i, u_j) = \frac{\vec{c}_{u_i} \cdot \vec{c}_{u_j}}{\left|\vec{c}_{u_i}\right|\left|\vec{c}_{u_j}\right|}, \tag{24}$$

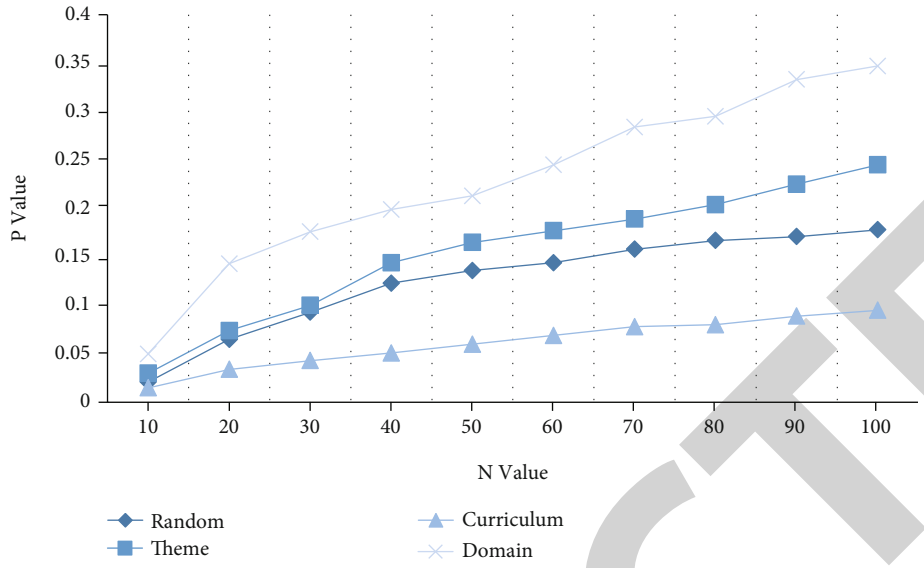
$$d\_\mathrm{sim}(u_i, u_j) = \frac{\vec{d}_{u_i} \cdot \vec{d}_{u_j}}{\left|\vec{d}_{u_i}\right|\left|\vec{d}_{u_j}\right|}. \tag{25}$$

3.3. Application Model of Side Supply Reform. According to the perspective of supply-side structural reform, we transform the ideological and political knowledge that colleges and universities should teach students into the question of what students need. College classrooms combine online and offline methods. From the perspective of students, they can use electronic devices to watch pictures, texts, audio, and videos related to ideological and political education anytime and anywhere from the screened knowledge base. There is no need to be forced to recite large sections of books and read obscure words because of the constraints of teaching tasks. They can plan or supervise their own learning in their own way from the perspectives of their own knowledge structure, learning style, interest direction, and mental state. In particular, the world has long been inseparable from the participation of the Internet, and there are huge amounts of information on electronic devices, including positive energy information that can be used for knowledge fusion, and there are also wrong ideas that students are difficult to distinguish, which requires correct guidance from university teachers. From the perspective of colleges and universities, it can greatly reduce the pressure of teaching progress and have tools that are more helpful to understand students' thoughts, abilities, and attitudes, so as to facilitate the adjustment of teaching policies. As far as the national society is concerned, the network platform spreads widely and is extremely fast. Students who have no precautions can easily walk into various "traps" and then change their values under the influence of negative information. Therefore, constructing students' personalized learning model, actively grasping students' psychological state, understanding students' ideological trends, and integrating ideological and political education into life with new media can effectively enhance the influence of mainstream ideology, as shown in Figure 2.

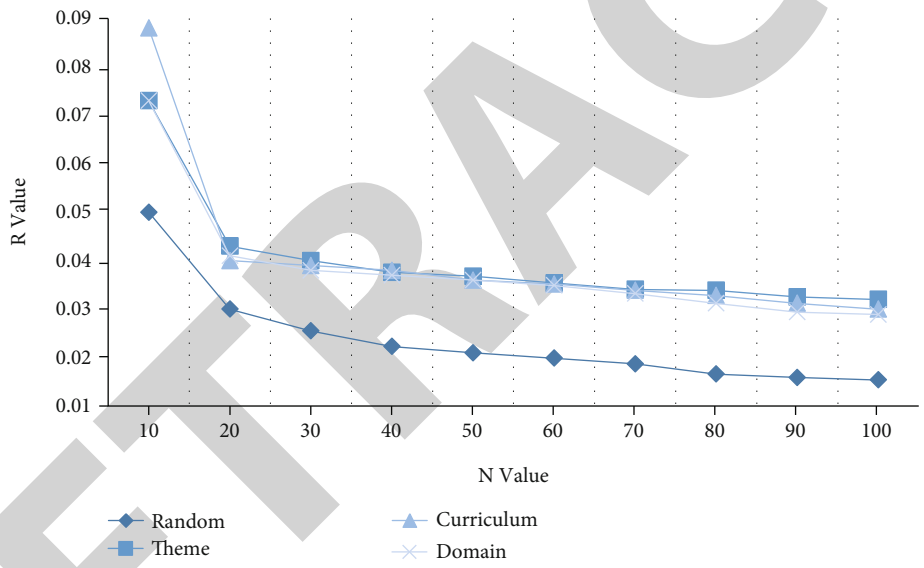
4. Experimental Analysis

4.1. Knowledge Fusion Model Testing

4.1.1. Comparison of Fusion Information Reliability. After obtaining the data, due to the unique nature of ideological and political itself, it has political and abstract uncertainty and practical testing, and its literal nature is very strong. If you want to get valuable or meaningful knowledge, you need to go through a series of pretreatment processes such as cleaning and screening. You need to use knowledge evaluation methods to verify the true value of knowledge and test the credibility of the obtained knowledge data. Only by continuously reducing the uncertainty of knowledge and screening out the wrong knowledge can the reliability and reliability of knowledge be improved. The real data we took in the experiment came from large open-source knowledge



(a) *P* value comparison

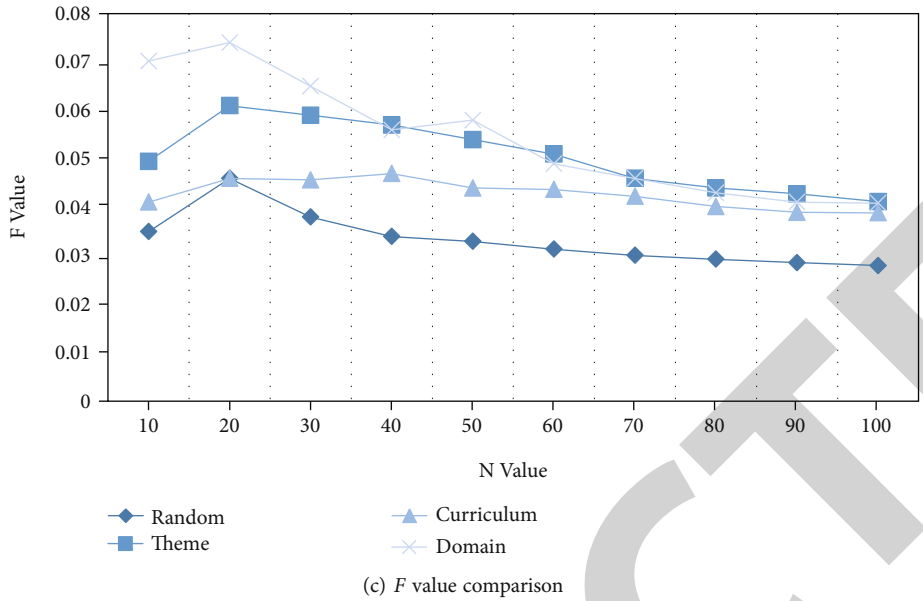


(b) *R* value comparison

Figure 5: Continued.

bases Freebase and WordNet. In addition, the data used in the experiment do not involve user privacy. Contrast Bayesian method, D-S evidence theory, fuzzy set theory, graph model, and the method obtained in this paper were used. According to the curve trend, we can clearly find that the error rate of the knowledge obtained by this method is as low as 9%, which is three times lower than that of Bayesian estimation method. In terms of accuracy performance, this method also shows its advantage as high as 91%. However, the computational efficiency is only 89%, and there is no outstanding performance. This is because the method we use adopts hybrid model, which is complicated and takes more time. Fuzzy set theory is improved on the basis of Bayesian and D-S evidence theory, so the accuracy is slightly higher than the other two, which can reach 84%. Graph model method can guarantee 88% accuracy in this test with the help of external auxiliary information, but it is always not as good as this method, as shown in Figure 3.

4.1.2. General Situation of Ideological and Political Knowledge Evaluation. Because the classroom mode after the reform of side supply has changed into "online + offline" mode, students will directly obtain teaching knowledge from the integrated knowledge base to a certain extent. Therefore, it is necessary to ensure that the education received by students has profound knowledge, which is in line with the nature of social ideology, and to ensure that the knowledge pushed for students online keeps pace with the times and has strong universality. In order to determine the effect of this method in different knowledge fields of ideological and political teaching, we select three groups of knowledge theories with different contents and emphases to carry out



(c) F value comparison

Figure 5: Experimental result diagram.

experiments and test seven different indicators. In the statistics of experimental results, we can find that the three groups of data in the timeliness have a big difference, only 86.1%, 85.6%, and 83%. However, the three groups of data of relevance, objectivity, accuracy, authority, verifiability, and universality have little difference and have good performance, as shown in Figure 4.

4.2. Learning Interest Model Test. The biggest advantage of this method is that the model can recommend students' interests according to the differences of different individuals and feedback the results to teachers. The main purpose of this test is to verify that the model can successfully describe and distinguish students individually. If the model cannot correctly distinguish the needs and differences between people, then this model still has great defects. We use the most basic collaborative filtering algorithm in the recommendation system, compare three vectors based on knowledge topic, course, and knowledge field, and add a random recommendation control group. Due to the limitation of various experimental conditions, we only selected 2000 students from the data set for the experiment. Compare the probability that students are interested in the pushed teaching content and set it as P value. The probability that the knowledge of interest appears in the learning list is set as R value. Because P value and R value are contradictory indexes, we should add a F value that can balance these two indexes, as shown in Figure 5.

From the data comparison of the three index values in Figure 5, we can find that the P value of the interest vector based on knowledge domain increases from 0.05 to 0.347 with the increasing N value, which is the best index in collaborative filtering recommendation. This is because when setting the vector, students' topics and course interests are considered comprehensively, so the division of knowledge fields is highly predictable, and the results are more in line with the experimental expectations. Compared with the corresponding R value, the probability of random recommendation decreases the fastest, and the R value is only 0.0154 when the N value reaches 100. The descent curves of the other three recommended methods gradually approach when the N value is 20, and the final probability is stable at about 0.03. From the equilibrium point of view, the F value of random recommendation is the lowest, while the other three methods perform better than it. Therefore, from a single level, recommending based on knowledge field is more in line with students' interests than simply recommending courses and topics. Therefore, the method in this paper is the most effective based on the fusion of three methods. This also reflects the positive significance of our side supply reform for ideological and political education in colleges and universities and stimulates colleges and universities to respond to students' demands for innovation and synergy.

4.3. Application Effect of Ideological and Political Teaching

4.3.1. Analysis of Students' Knowledge Level. For college students, the model proposed in this paper is put into use in a college teaching situation, and the actual effect of the model is verified to determine whether it is available. In this section, we mainly aim at the comprehensive evaluation of students' knowledge level. The results are counted from five aspects: grades, prolongation of study time, improvement of study initiative, rise of knowledge level, and change of thirst for knowledge. The experiment invited three classes A, B, and C of the same major as test points. Set the control group class F, that is, the class without this reform model. After a semester's study, the students' understanding of ideological and political education is tested. Compared with the pure theory teaching

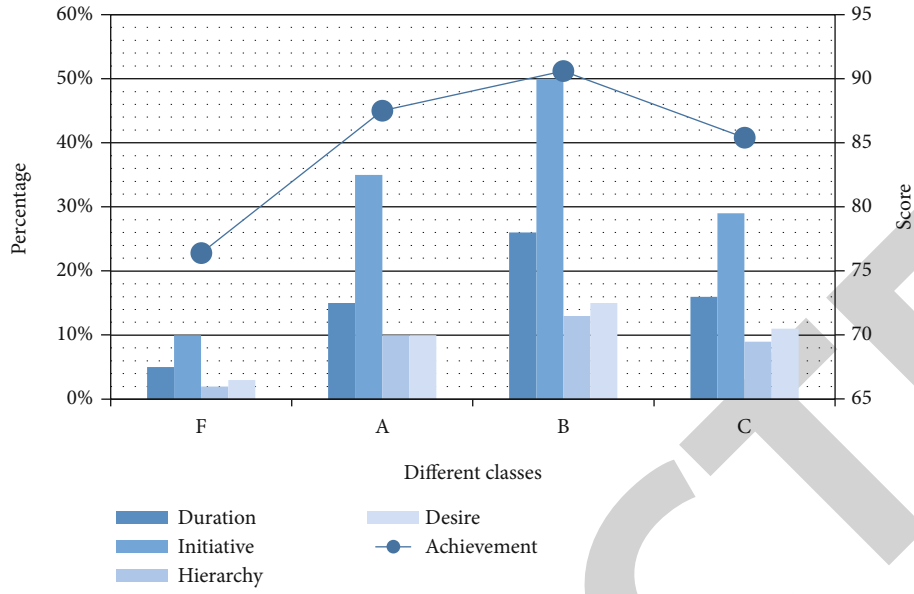


Figure 6: Knowledge level assessment results.

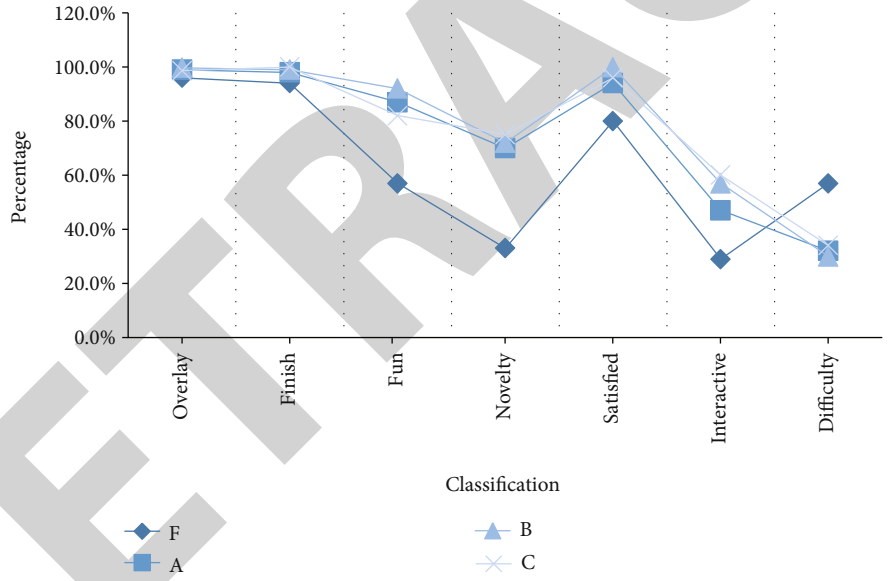


Figure 7: Classroom teaching quality inspection.

class, we can find that the classroom structure reform class performance has obviously improved to varying degrees. The comprehensive score of class F is only 76.4, while the scores of the other three classes are all above 85, among which class B is as high as 90.6. Students in classes A, B, and C are no longer limited to the limited knowledge taught by teachers in class but use electronic equipment to learn in rich forms. Supply-side reform fully mobilizes the initiative of learning, improves their own knowledge level, and makes students more willing to seek knowledge and explore, and student is willing to spend more time deeply understanding the ideological and political content and spiritual connotation and development, as shown in Figure 6.

4.3.2. Analysis of Classroom Education in Side Supply Mode. In addition to assessing the changes of students' subjects, we should also analyze the quality of ideological and political teaching in the whole classroom. Therefore, we will make statistics on the data results according to the coverage rate of ideological and political knowledge points in colleges and universities, the progress of teaching tasks, the fun of teachers and students in class, the novelty of knowledge transfer, the satisfaction of colleges and universities, the difficulty of learning, and the interaction between teachers and students. The experiment is still carried out for the four classes in the previous section. After the reform of the side supply model, the knowledge points of the three classes are

covered, and the progress of teaching tasks is close to 100%, while the coverage rate of class F is only 96%, and the teaching completion is only 94%. From a novel point of view, the three classes A, B, and C have increased by nearly 40% compared with class F, and students' classroom interaction has increased significantly, and their learning fun is higher. The satisfaction of colleges and universities with ideological and political education is also in line with expectations. The difficulty of students studying courses can be reduced by about 20% to 30%, as shown in Figure 7.

5. Conclusion

As an important link of cultivating and exporting talents to the society, colleges and universities should cultivate students' various qualities in all directions. It is worth noting that the reform from the perspective of supply side must focus on the needs of students. The goal, content, method, and other elements in the process of education all serve around the subject and strive to achieve a coordinated balance point. For the external environment, it can provide good collaborative conditions, meet the individual actual needs of students, and ensure and expand the learning scope outside the classroom. Based on the background that intelligent education promotes the development of modern educational Informa ionization and the support of computer technology, this paper uses Bayesian estimation, graph model, and fuzzy set theory to evaluate knowledge and combines domain knowledge model and learner knowledge model to extract knowledge that conforms to ideological and political education in colleges and universities from massive data for fusion. Effectively build a knowledge base that can be used to solve problems, broaden students' life depth, and enrich their horizons. With the help of network platform as the carrier, through statistics and evaluation of each student's learning behavior and learning preference, teachers can better control the classroom. It is necessary to further promote the supply-side reform path of ideological and political education in colleges and universities.

Although this experiment has achieved some research results, but limited by technology, funds, equipment, and other factors, this topic cannot be fully realized and meet the practical application of college classroom. This means that there are still a lot of problems to be solved in the follow-up work. Among them, using mega data can improve the practical effect of knowledge base, but the current fusion technology still has a lot of challenges. Because information from different sources has different timeliness and update frequency, the existing methods mainly aim at static knowledge, but it is difficult to correctly evaluate this dynamic time series knowledge. In addition, there are too few data sets and experimental samples for training, which cannot verify the universality and effectiveness of the experiment. In addition to the personalized function of helping learning, we should also consider appropriately enhancing the interaction between teachers and students and offline activities, so that teachers can play the role of ideological leaders and fully fulfill their educational mission.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

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Research Article

Classification of Videos Based on Deep Learning

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Automatic classification of videos is a basic task of content archiving and video scene understanding for broadcasters. And the time series modeling is the key to video classification. To solve this problem, this paper proposes a new video classification method based on temporal difference networks (TDN), which focuses on capturing multiscale time information for effective action classification. The core idea of TDN is to design an effective time module by clearly using the time difference operator and systematically evaluate its impact on short-term and long-term motion modeling. In order to fully capture the time information of the entire video, TDN has established a two-level difference model. For local motion modeling, the time difference in consecutive frames is used to provide a more refined motion mode for convolutional neural network (CNN). For global motion modeling, the time difference of the segments is combined to capture the remote structure for the extraction of the motion feature. The experimental results on two public video anomaly detection data sets, namely, UCF sports data set and SVW field sports data set, prove that the performance of the proposed method is better than some existing methods.

1. Introduction

Due to the massive ratings of different sports events around the world, sports broadcasters have produced a large amount of video content. According to statistics, more than half of the world's population (about 3.6 billion) watched the 2018 Men's Football World Cup, and the global viewership of the 2020 Olympic Games in Japan reached about 4 billion. In addition, a similar increase in viewership has also occurred in other sports around the world, which has brought great challenges to manually analyzing and processing such a large amount of video content. Therefore, there is an urgent need to develop effective methods to automatically process and analyze a large number of sports videos appearing in cyberspace. Among them, automatic video classification provides important technical tools for a series of applications, such as video indexing, browsing, annotation, and retrieval, as well as improving the efficiency and effectiveness of its access to sports video archives.

Since video is composed of many single image frames, video processing can be computationally challenging [1, 2]. Therefore, one method of video classification is to simply examine the frames as a single image and try to classify them and then combine the results into a single output classification of the entire video. Although this idea is relatively intuitive, people can use a single frame to distinguish between shots and shots. But most of the time, the information encoded in the video is discarded. In order to solve this problem, there are already many researchers classifying videos based on video features, audio features, and other videos. Literature [3] used two different neural network methods and texture feature methods and combined them to compare the results of all three methods. In literature [4], Gade et al. used thermal imaging technology to generate heat maps and then used principal component analysis (PCA) and Fischer linear discriminator to project the heat maps into a low-dimensional space and then classify them. As reported, this method achieved good results in five categories. On this basis, Gade et al. [5] combined the Mel frequency cepstral coefficient (MFCC) features of audio and visual motion features to classify motion videos and obtained very good classification results. The literature [6] fused the three kinds of data of video, audio and sensor in the motion video, and used the multiclass support vector machine (SVM) method for classification. Literature [7] used a hidden Markov model (HMM) method to identify

events in videos and classify them, but the results only provided computational time performance without mentioning the accuracy.

In the past ten years, deep learning theory has been widely used in computer vision fields such as image and video processing [8], and great breakthroughs have been made. Unlike images, video contains a lot of time information, so a large number of researchers have carried out research on how to represent the time information in the video. Ji et al. [9] proposed a 3DCNN across spatial and temporal dimensions to extract information about the motion that occurred between frames. At the same time, literature [10] employed the time pooling method and long short-term memory (LSTM) method to represent time information. Wang et al. [11] proposed a more widely applicable action recognition method, which gone beyond the layer type and model architecture. The method divided each video into multiple blocks, and then classified each block into micro videos, and then aggregated the results of all predictions to generate a final prediction for each complete video. Literature [12] studied video classification relying on fusion of time information from different frames, using three different strategies: early fusion, late fusion, and slow fusion. It found that slow fusion achieved the best result in these models.

This paper uses the temporal difference network (TDN) to achieve video classification. The proposed method can capture multiscale time information and further realize the timing descriptions of different videos. The core of TDN is to design an effective time module by explicitly using the time difference operator and systematically evaluate its impact on short-term and long-term motion modeling. In order to fully capture the time information of the entire video, TDN established a two-level difference modeling paradigm. For local motion modeling, the time difference on consecutive frames is used to provide a fine motion pattern for CNN. For global motion modeling, the time difference across segments is combined to capture the long-term structure for motion feature excitation. Experiments on two public data sets show that the classification performance of the proposed method exceeds the state of the art.

2. Algorithm Principle

The TDN-based method proposed in this paper actually uses the entire video information to learn the video action model. Due to the limitation of GPU memory, following the temporal segment networks (TSN) framework [13], a sparse and overall sampling strategy is proposed for each video. Different from the TSN method, the TDN proposed in this paper mainly uses the time difference operator in the network design to clearly capture short-term and long-term motion information. In order to improve the efficiency of the algorithm, this paper incorporated the residual connection into the main network to complete the motion supplement in the local window and the motion enhancement across different segments. Specifically, each video is first divided into segments of equal duration and nonoverlapping. Next, a frame is randomly sampled from each segment, and a total of T frame $I = [I_1, I_2, \cdots, I_T] \in \mathbb{R}^{T\times C\times H\times W}$ are obtained. These frames are input to CNN to extract frame-level features $F = [F_1, F_2, \cdots, F_T]$, in which $F \in \mathbb{R}^{T\times C'\times H'\times W'}$ represents the feature representation in the hidden layer. The purpose of the short-time difference module is to provide local motion information for these frame-by-frame representations of the previous layers to improve their representation capabilities:

$$\widehat{F}_i = F_i + \mathscr{H}(I_i), \tag{1}$$

where $\widehat{F}_i$ represents the enhanced representation of the timing differential module and $\mathscr{H}$ represents the short-time difference module, which can extract the local motion of I_i in the surrounding adjacent layers. The long-term difference module is used to enhance the frame-level feature representation by using the span time structure:

$$\widehat{F}_i = F_i + F_i \odot \mathscr{G}(F_i, F_{i+1}). \tag{2}$$

where $\mathscr{G}$ represents the long-term difference module. As only adjacent segment-level information is considered, the long-term modeling can be performed in each long-term difference module. By stacking multiple long-term difference modules, the long-term time structure can be captured.

2.1. Short-Time Difference Module. Adjacent frames in a video are very similar in a local time window, and it is inefficient to directly stack multiple frames for subsequent processing. On the other hand, sampling a single frame from each window can extract appearance information, but cannot capture local motion information. Therefore, the short-time difference module chooses to provide a single RGB frame with a time difference to produce an effective video representation to simultaneously encode appearance and motion information.

Specifically, the short-time difference module performs low-level feature extraction in the first few layers of the neural network and enables a single frame of RGB to capture local motion by fusing time difference information. For each sample frame I_i, the partial window extracts the timing RGB difference and then accumulates it into the channel dimension $\mathbf{D}(I_i) = [D_{-2}, D_{-1}, D_1, D_2]$. Accordingly, the effective form of TDM can be expressed as

$$\mathscr{H}(I_i) = \text{Upsample}(\text{CNN}(\text{Downsample}(\mathbf{D}(I_i)))), \tag{3}$$

where $\mathbf{D}(I_i)$ represents the RGB difference around and CNN is a specific neural network at different stages. In order to maintain efficiency, this method designs a lightweight CNN module to deal with stacked RGB differences $\mathbf{D}(I_i)$. It usually follows a low-resolution processing strategy: (1) The average pooling is used to downsample the RGB difference to half. (2) CNN is used to extract motion features. (3) The motion features are upsampled to match RGB features. This is because the RGB difference shows a very small value in most areas and contains high response only in areas where motion is significant. Therefore, it is sufficient to use

a low-resolution architecture for this sparse signal without losing too much accuracy. The information of the short-time difference module is merged with a single RGB frame, so that the original frame-level representation understands the motion mode and can better describe the local time window. This fusion is achieved through the horizontal connection, and the fusion connection of the short-time difference module is attached to the frame-level representation of each early stage. In practice, the residual connection is also compared with other fusion strategies.

2.2. Long-Time Difference Module. The frame-by-frame representation of the short-time difference module is very effective for capturing spatio-temporal information in the local segment (window). However, this representation is limited in terms of time receptive field, so it is impossible to explore the long-term time structure of the learned action model. Therefore, the long-term difference module attempts to use cross-segment information to enhance the original representation through the new two-way and multiscale time difference module. In addition to efficiency, the lack of alignment of spatial positions between long-term frames is another problem that needs to be solved. Therefore, this method designs a multiscale architecture to smooth the difference in the large receptive field before the difference calculation. The feature dimension is first compressed into a ratio and convolved to improve efficiency, and the alignment time difference is calculated through adjacent video clips:

$$C(F_i, F_{i+1}) = F - \mathrm{Conv}(F_{i+1}), \tag{4}$$

where $C(F_i, F_{i+1})$ represents the difference in the alignment time of the segment, which is used for spatial smoothing channel convolution, thereby alleviating the lost alignment problem. Then, the aligned time difference is extracted through the multiscale module for long-term motion information:

$$M(F_i, F_{i+1}) = \mathrm{Sigmd}\left(\mathrm{Conv}\left(\sum_{j=1}^{N} \mathrm{CNN}_j(C(F_i, F_{i+1}))\right)\right). \tag{5}$$

In Equation (4), different spatial scales are designed to extract motion information from different receptive fields. In practice, $N = 3$. For missing alignment problems, their fusion may be more robust. In terms of implementation, it involves three branches: (1) short connection, (2) 3×3 convolution, and (3) average pooling. Finally, the two-way span time difference is used to enhance the frame-level features, as shown below:

$$Fi \odot \mathcal{G}(F_i, F_{i+1}) = Fi \odot \frac{1}{2}[M(F_i, F_{i+1}) + M(F_{i+1}, F_i)], \tag{6}$$

where $\odot$ denotes element-wise multiplication.

The proposed method also combines the original frame-level representation and enhances the representation through residual connection. For example, Equation (2) is slightly different from the short-time difference module. The difference representation is used as the attention map to enhance the frame-level features. This part based on the observed attention model is more effective in the later stage of CNN. In practice, the residual connection is also compared with other fusion strategies.

In summary, the TDN-based method proposed in this paper is based on the sparse sampling of TSN, which operates on a series of frames evenly distributed across the entire video. TDN provides a two-level motion modeling mechanism, focusing on capturing time information in a local to global manner. In particular, the short-term timing difference module is inserted in the early stage to perform finer and low-level motion extraction. And the long-term timing difference module is inserted in the later stage to perform more coarse and advanced time extraction structure modeling. Similar to the residual network [14], this method adopts its main structure. The first two stages use a short-time difference module to extract short-term information, and the latter three stages are equipped with a long-time difference module to capture the cross-period timing structure. In order to improve computational efficiency, two measures are adopted. For local motion modeling, a residual connection is added between the short-time difference module in the first and second stages and the main network. For long-term motion modeling, a long-term difference module is added to each residual block.

3. Experiment and Discussion

In this section, the effectiveness of the proposed method is verified and compared with other existing methods. First, the two public data sets used for evaluation are briefly introduced. Then, the experimental details are given. And finally the experimental results are analyzed.

3.1. Experimental Data. Two data sets are used for experiments, and their basic descriptions are given in Table 1. The UCF Sports Action data set [15] is composed of a set of actions collected from various sports. These sports are usually broadcast on radio and television channels, and the video sequences are obtained from various material websites. The data set contains the following 10 sports: diving (14 videos), golf swing (18 videos), kicking (20 videos), weightlifting (6 videos), horse riding (12 videos), running (13 Video), skateboard (12 videos), swing stool (20 videos), swing side (13 videos), walking (22 videos), and sample frames are shown in Figure 1. The data set includes a total of 150 sequences with a resolution of 720×480 and 10 fps. The available annotations are the bounding box for action positioning and the class label for activity recognition. In addition, the data set also provides annotations from the audience.

In addition, this paper also uses the SVW field sports data set for experiments. The data set consists of 4200 videos taken by Coachs Eye smartphones. The Coachs Eye smartphone application is an application for sports training developed by TechSmith. The data set includes 30 types of sports and 44 different actions. Compared with the UCF sports

Table 1: Basic descriptions of the two data sets.

Data set	Number of sports	Number of videos	Resolution
UCF	10	150	720×480
SVW	30	4200	480×272 to 1280×720

(a) UCF data set

(b) SVW data set

Figure 1: Examples in the two data sets.

action data set, this data set is more complex. Most of the videos taken are amateur sports videos. At the same time, the shooting methods are not as professional as TV videos. First, the static image context has a low degree of discrimination for classification. Second, the cluttered background and common environment will also bring difficulties to unconstrained sports video classification. Then, amateur users' nonprofessional shooting brings additional challenges, such as extreme camera vibration, incorrect camera movement, being obscured by the audience, judges and fences due to improper camera position, and unusual viewing angles. Some examples of the SVW field sports data set can also be observed in Figure 1.

3.2. Experimental Data and Evaluation Indicators. In the experiment, this method uses the ResNet50 network to implement the timing difference module and samples the time frame from each video $T = 16$. During training, each video frame is adjusted to have a shorter edge in and is cropped randomly 224×224. The method is pretrained on the ImageNet data set. The batch size is 128, the initial learning rate is 0.001, and the number of iterations is set to 100. When the performance of the validation set is saturated, the learning rate will be reduced to 0.0001. For testing purposes, the shorter side of each video was adjusted to 256, and then, only the 224×224 center crop of a single clip was used for evaluation. The hardware environment of the whole experiment process is Intel Core i7-10700 2.9GHz CPU, NVIDIA GeForce GTX 2080Ti (11 GB video memory) GPU, and 32GB RAM memory, and the computing platform is Python 3.7 and Tensorflow2.0.

3.3. Experimental Results. For the UCF sports action data set, 75% of the video clips are used for training, and the remaining 25% are used for testing. In order to prove the effectiveness of the proposed method in video classification, this paper compares it with the some existing methods. These methods include manual feature methods and deep learning methods, mainly including Wang et al. [16], Le et al. [17], Kovashka et al. [18], Dense trajectories [19], Weinzaepfel et al. [20], SGSH [21], snippets [22], and two stream LSTM [23]. Among them, the latter two are deep learning methods, and the others are manual feature methods.

Table 2 gives the classification accuracy of each kind of sports in the UCF data set. Table 3 shows the classification results of various methods. It can be observed that the

Table 2: The accuracy each class of UCF Sports data set.

Class	Accuracy
Diving	100%
Golf	89.7%
Skate boarding	93.1%
Swing bench	100%
Kicking	100%
Lifting	100%
Riding horse	100%
Running	100%
Swing side	100%
Walking	91.1%

Table 3: Comparison with the state of the art methods (UCF data set).

Method	Mean Acc.
Wang et al. [16]	85.6%
Le et al. [17]	86.5%
Weinzaepfel et al. [20]	90.5%
SGSH [21]	90.9%
Snippets [22]	97.8%
Two stream LSTM [23]	98.9%
Proposed	99.3%

Table 4: Comparison with the state of the art methods.

Method	Test I	Test II	Test III	Mean Acc.
Motion-assisted	\	\	\	39.1%
Context-based [24]	\	\	\	37.8%
Combined CNN [25]	81.9%	82.1%	83.4%	82.5%
RWRS [26]	84.5%	84.3%	85.3%	84.4%
Proposed	87.5%	88.5%	86.3%	86.8%

performance of the deep learning method is better than the manual feature method, and the method proposed in this paper achieves the best classification result of 99.3%, which exceeds the two stream LSTM [23] method 0.5%. This is mainly because the TDN used in this paper can better describe the timing structure in sports videos. It can be seen from the individual sports classification results in Table 3 that most of the sports classification accuracy rates in this data set have reached 100%, except for golf, skateboarding, and walking sports. The reason for the confusion of these kinds of sports videos is that they all have the same action, that is, the action of walking.

For the SVW data set, the experiment adopts the same training/testing configuration described in [24], in which there are 3 different training/testing set division methods. The experimental comparison can be shown in Table 4. From Table 4, it can be seen that the method proposed in this paper is better than the motion-based [24] (motion-based feature, HOG feature, and SVM classifier) method provided by the original data set. The performance is 27% higher than that of the CNN method [25, 26]. Specifically, it can be seen from Table 4 that the accuracy of the "running" event category is the worst. Most of the errors are that the classifier misclassifies the "running" event category image as the "long jump" event category. These problems arise because there are a lot of the same actions between the long jump and running, especially when the long jumper runs up.

4. Conclusion

This paper proposes a video classification method based on TDN, which is used to learn sports action models from the entire video. The core of the timing difference network is to generalize the time difference operator into an efficient general-purpose time module with a specific design, which is used to capture short-term and long-term time information in the video. As the experimental results on two public data sets show, the performance of the extracted time series difference algorithm is better than other previous methods. In the next step, the timing differential network will be improved to replace the 3DCNN commonly used in video modeling for video classification.

Data Availability

The data sets used in this paper are can be accessed upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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Retraction

Retracted: On the Application of BIM Technology and Neural Network Algorithm in the Study of Energy-Saving Optimization of the Envelope Structure of Assembled Buildings in the Western Sichuan Plain

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] H. Li, X. Li, Y. Jiang, and C. Wei, "On the Application of BIM Technology and Neural Network Algorithm in the Study of Energy-Saving Optimization of the Envelope Structure of Assembled Buildings in the Western Sichuan Plain," *Journal of Sensors*, vol. 2022, Article ID 1653838, 12 pages, 2022.

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Research Article

On the Application of BIM Technology and Neural Network Algorithm in the Study of Energy-Saving Optimization of the Envelope Structure of Assembled Buildings in the Western Sichuan Plain

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With the rapid development of the economy, carbon neutral and carbon peak are on the agenda in China, and the reform of intelligent construction and assembly building is in full swing in the Chinese construction industry. In order to further explore and study the relationship between the textural structural issues of the envelope structure and the overall energy consumption situation of the house, and further bridge the gap between the actual energy-saving design scheme and the actual application scheme, therefore, this paper takes a certain place as a research object to study the phenomenon of design assembly energy saving, based on dozens of assembly building enterprises researched, selected samples of envelope components studied, selected BIM technology for premodeling optimization, used neural network algorithm for analysis of influencing factors, and studied the application in the study of energy-saving optimization of assembly building envelope in the western Sichuan plain area, and used OpenStudio was used to build a model to simulate the heating and air conditioning load of the assembled building numerically and to fit the quantitative relationship between the variable factors and the building energy consumption. On this basis, the relationship between multifactor and single-factor variables is identified and evaluated using relevant variables means.

1. Introduction

With the rapid development of the economy, carbon neutrality and carbon peaking are on the agenda in China, and the reform of intelligent construction, green building, and assembled building is in full swing in China's construction industry. During the development of China's modernization, the construction industry has been the focus of attention because it is related to the safety of people's lives and properties [1]. With the introduction of modern energy conservation and sustainable development concepts, the construction of assembled buildings will take the dominant position. The assembled building has the advantages of improving construction efficiency, saving construction cost, energy saving, environmental protection, and noise reduction. The introduction of building science and technology has accelerated the industrialization of the construction industry into assembled buildings [2]. Therefore, the development of the construction industry must be considered and supported. Building information modeling (BIM) is a technical abbreviation for building information modeling, a simulation based on three-dimensional digital technology [3]. Specifically, in digital terms, it can clearly show the condition of the building before its construction, so that problems can be reduced.

Therefore, the application of technology in the construction process can lead to unprecedented developments in the construction industry, especially for the optimization of the energy efficiency of the envelope of assembled buildings, where BIM technology can be used to save time and costs with its premodeling capabilities for optimization studies [4].

The core of assembled buildings is "integration", and the building management information system (IMSMA) technology is an "integration" tool for the whole life cycle of prefabricated design, manufacturing, construction, renovation, and construction management [5]. BIM technology provides powerful technical support for prefabricated structure construction planning, and 3D BIM models can solve the problem of frequent structural collisions in 2D design, which greatly reduces "errors, leaks and collisions" in the project and improves work efficiency [6]. Construction information management technology enables standardized planning, performance planning, precast accounting, piping optimization, and foundation testing to be performed in the planning stage [7]. Design, collision detection, and design module modeling can be performed at a deeper stage. BIM-based modular construction process for construction planning of prefabricated structures. Combining traditional shop design with in-depth structural design enables a more standardized process. Modularity is a series of standard design modules consisting of standard functional modules [8]. Modular design uses a system of standard construction modules to improve production efficiency, reduce the cost of parts in the manufacturing process, simplify the assembly of parts, adjust the type of relevant construction materials and parts, and achieve assembly integration. When creating a library of modules, they are aggregated into structural models, such as "structural blocks," which provide a basis for visualizing decisions [9].

Artificial neural networks do not have to determine in advance the mathematical equations associated with the input and output cards, simply because you need to train your brain system to learn further mathematical rules [10]. When you input the rules expected by the value of the input function, you end up with the simplest mathematical result that is close to the value of the input function. Artificial neural network system is one of the intelligent information computing and processing systems, and one of its main core functions is training algorithms. In this paper, we analyze and discuss the influencing factors through the neural network construction algorithm system.

This paper first summarizes the overall climate characteristics, and then systematically summarizes the climate for the plains in the western Sichuan region, and determines the energy consumption factors based on the summarized results. After that, the parameters of the maintenance structure of the assembled building are limited in scope, and OpenStudio software is used to simulate the energy consumption values at a later stage, so as to determine the method of the simulation and the evaluation index of the benefits, to derive the relationship between the energy consumption of the facade of the assembled building and the building, and to draw an energy consumption diagram.

2. Research Background

The main applications of BIM technology in engineering are, as Zhuji reviewed, the advantages of the application of general contractor construction organization and management technology and construction organization technology [11]. It is hoped that general contractors will seize the opportunity of applying new technologies in construction organization, actively participate in the development and implementation, improve the level of enterprise project management and market competitiveness, and drive the transition of enterprise management to a new stage. According to Zhang, building information simulation technology, as a 3D visualization and simulation technology, can establish an ideal information sharing platform based on the entire design information and effectively improve the overall level of project management [12]. Construction information technology has become one of the most important aspects of home construction. The application of construction information modeling in general contractor project management is studied in detail in the hope that it can provide some help to China's construction project management. Joseph J described the eight stages of BIM marketing plan and argued that owners and developers are changing their perceptions of BIM services [13]. Specifically, when the construction business is still in its infancy, a client or prospect may submit a proposal containing a vague definition of the scope of the construction work. Currently, both the client and the prospect have specialized knowledge and experience in the actual projects of the construction business, but he proposes a marketing development program based on the technology of the construction business to help increase the marketing revenue of the construction business. To ensure the construction cycle, installation quality, and economic efficiency of subway stations, Lee proposed the introduction of building information modeling (BIM) to address subway station construction safety issues. The application methods and effectiveness of BIM are studied from the perspective of integrated pipeline modeling and four-dimensional modeling, and it should be noted that the project cycle can be reduced by 15%, but it is assumed that the effectiveness of BIM needs further study. Mark believes that modern BIM can be used to develop models. It covers technical information, particularly the design, construction, and operational cycles of many projects, and argues that this can lead to shorter construction times, cost savings, and quality. Therefore, the advantages of the application are particularly obvious [14].

The study of energy-saving technologies for envelope structures has been carried out mainly by scholars in Beijing and other places for some energy-saving materials and energy-saving methods for relevant public buildings in the region, as well as for building structures, to explore the current status and energy-saving methods for buildings in different fields [15]. Xu Xiaoli studied and analyzed a residential building in Tianjin using CFD techniques, and by the analogy with MATLAB models, she designed an intelligent control system for indoor cold and blood heat sources [16]. Dean et al. studied the protection facilities of the cooling zone in summer and winter through computer

simulation. Scholars Qiankun Wang et al. have further extended their research on the optimization of energy efficiency of building structures by using BIM technology, as well as algorithms such as neural networks and related data mining techniques for assembled building enclosures in Wuhan [17]. Foreign scholars have further explored the structural and energy-saving optimization of assembled buildings. The research was conducted on the basis of the network [18]. Liu summarized the development status of prefabricated components in China, presented the problems, and summarized the relationship between exterior wall (SI) structures and energy efficiency based on the analysis of various data. Current domestic and foreign scholars have not made an in-depth analysis of the problems related to energy consumption of assembled buildings, although they have done research and analysis on the envelope structure of assembled buildings, especially in the board of the domestic assembly design of the city, the research on the energy saving of such assembled buildings is in a backward state compared to foreign countries, especially the city design of the program is seriously derailed [19]. Domestic scholars always analyze energy consumption after qualitative research on architectural design solutions, which is not coherent and leads to many problems. The core of this thesis is to help architectural designers to reduce the interference of relevant factors in the selection of the best building solutions, thus providing the best energy-saving design solutions, and to help architects to have a deeper understanding of the selection of materials and their thicknesses for the maintenance structures of assembled buildings, so as to obtain the best energy-saving solutions with the highest economic efficiency [20].

3. Research Methods and Materials

3.1. BIM Technology

3.1.1. Concept. BIM technology is a product of information technology, so it uses multimedia for model modeling and building data to represent building components. But it is not just a modeling method, it is a new concept, and it is digital information modeling. It simplifies architectural innovation, building design, building models, and processes in prefabricated buildings.

3.1.2. Features. The application of BIM technology in architecture is characterized by high coordination, visibility, graphical design, and high simulation intensity as shown in Figure 1.

High degree of coordination: If this problem is difficult to solve, BIM technology can be used because it has high adaptability. Designers and designers can simulate the 3D construction site according to the actual situation of the construction site and seek solutions through the model.

Visibility: One of the main problems of architectural design is interior architecture. A construction model is a visual and spatial model that allows construction workers to clearly see every location, greatly reducing errors in complex and hidden locations. Compared to 2D graphics, designers can reduce tremendous intellectual labor and design time, and can also correct errors by searching the modeling framework, greatly increasing the usability of the designer.

Modeling: Modeling is the main construction method, but not only simulates the already built model, but also simulates the virtual construction process. The main simulation methods include solar simulation, full-spectrum image simulation, and heat transfer simulation. In addition, the actual simulation can be based on four-dimensional simulation technology (project development time or three-dimensional simulation), while the preparation of the proposal phase can greatly improve the success rate.

High simulation intensity: Architectural works are inseparable from the use of working drawings, but their preparation is different from 2D working drawings. Optimization of construction planning drawings, pipeline data, model sequences, and maintenance of structural shutters is discussed in detail on the basis of visual display of buildings through multifaceted analysis of the model.

3.2. Neural Network Algorithm. Neural network is essentially a model of nonlinear prediction; as his name suggests, it is an algorithm that imitates the human and animal-like nervous system for computation. It is based on imitating the human and animal brain neural network system to perform the computation and then to process the content of each module. Neural network algorithm is a derivative of data mining technology, which is one of the types of data mining technology that can be used for big data mining, such as analysis, classification, aggregation, and other data mining functions. Its advantages and disadvantages are very clear, the first advantage is that it is extremely resistant to interference, and the second is that it is capable of deep learning and better memory in a nonlinear situation and can handle more complex situations. At the same time, it has two disadvantages. First, its computation and processing results are low-dimensional and cannot be adapted to a high-dimensional environment, so it has a hard-to-interpret nature. The second is that whether it is supervised or unsupervised learning, it requires a long learning time and data collection using more traditional neural network methods.

3.2.1. Generalized Regression Neural Network. Generalized regression neural network generalized regression neural network (GRNN for short) is a four-layer forward propagation neural network; its network structure has fewer parameters and better nonlinear mapping ability; and of course, this kind of neural network its initial point is the input layer, the end is the output layer, and then after two intermediate layers are the pattern layer and the summation layer to get the output of this kind of neural network algorithm. The difference between this neural network and other neural network algorithms is that there is no supervised learning and unsupervised learning data input and training process. The training results are obtained by optimizing the relevant factors in the second layer. It does not have a specific computational process like other types of neural networks, but has a specific supervised and unsupervised learning data

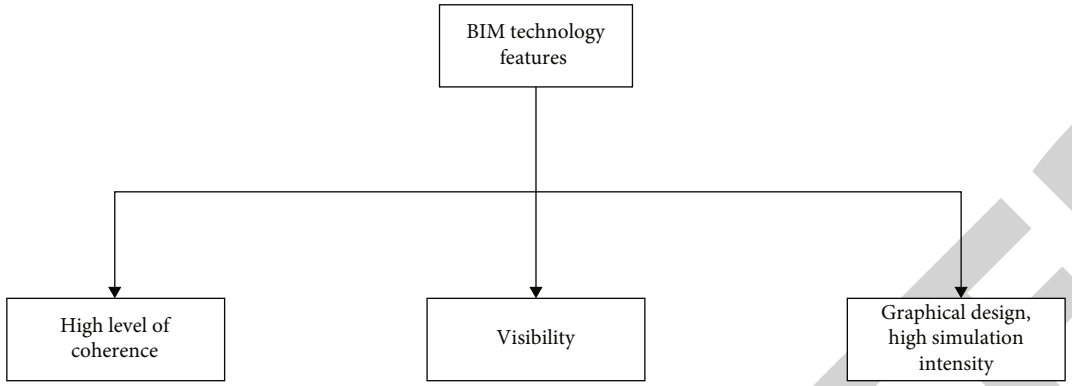

Figure 1: BIM technology characteristics.

processing process and training process. The computational process is not shown in detail here, and the specific computational process can be obtained by the radial basis neural network inference, which will not be done in this example. Although this kind of neural network combined with the generalized theory, it does not require supervised and unsupervised learning training, but its second layer, that is, its mode layer, is prone to the phenomenon of violation of statistical laws; Firstly, it is very easy to cause the phenomenon of underfitting and not easy to fit, and secondly, the relevant factors in his will appear random wandering phenomenon, so it is more troublesome as shown in Figure 2.

3.2.2. Wavelet Neural Network. This paper focuses on data processing using a two-part algorithm for neural networks. These two types of algorithms are effective supervised learning and ineffective unsupervised learning, which are common in algorithms. In the latter part, the data are first analyzed by certain algorithms for clustering, so as to obtain the central part of the hidden neural network, and then, the results of this step are used to perform calculations to figure out the value of the width of the number. The wavelet neural network and the structure of which are shown in Figure 3.

3.2.3. Fuzzy Neural Network. This type of neural network (FNN for short) is, first of all, a deep combination of fuzzy theory and neural network algorithm. In the process of data mining and information processing by neural network algorithms, fuzzy theory is incorporated to improve the mapping and the relevance of mathematical relationships. The efficiency of supervised learning and unsupervised learning is better improved. The algorithmic formulas of such neural networks and the related structural diagrams are more commonly used and common and can be found in general textbooks. This kind of neural network is shown in the figure, and it goes through five levels in the process of training and supervised and unsupervised learning; at the beginning of the two levels, as the level increases, the range of calculations required will double, but as it enters the third level and enters the fourth level and enters the fifth level, the content of calculations will gradually decrease until it becomes one. Of course, when this type of graph is input, the first thing is to test the dimensionality at the node of the input layer and test the dimensionality. The specific value assumes that the dimension value is n and the node that needs to be input is n. Depending on the number of nodes required, it is passed all the way to the layer of the dimensionality function and the related layer of functions for further computation, as well as finally to the output layer. This type of fuzzy theory combined neural network has the same nature as the wavelet neural network and the neural network combined with generalized theory in that it uses the traditional gradient form of computation downward to calculate the centroid of the affiliation and the associated required width value and the final output value and the weights we need. This is shown in Figure 4.

3.3. Assembly Building. Prebuild is a suitable method for the discussion of the actual construction process. The basic principle of construction is that the components required for manufacturing prefabricated components must be assembled and used at the construction site in the workshop, and the prefabricated components must be assembled from the building. Assembled buildings are integrated assemblies that can be standardized in design and managed with information technology. Its unique design, short construction time, and cost savings are the links that enable the construction industry to grow. Building assembly attracted people in the early twentieth century, but the first assembled buildings were simple, large, and uniform. Subsequently, architects improved them, creating a variety of exterior structures, increasing the flexibility of the building, and providing a qualitative mastery of the completed building. In recent years, with the development of technology in all sectors of society, the construction industry will flourish with the support of technology.

3.4. Energy-Saving Design

3.4.1. Regional Climatic Characteristics of Cold Winters and Hot Summers. The relevant units in the current society are trying to achieve high efficiency and achieve energy saving as much as possible. The current building code "Thermal Design Code for Civil Buildings" (GB50176-93) divides China into five climatic regions. Since different external environments are bound to have different degrees of impact

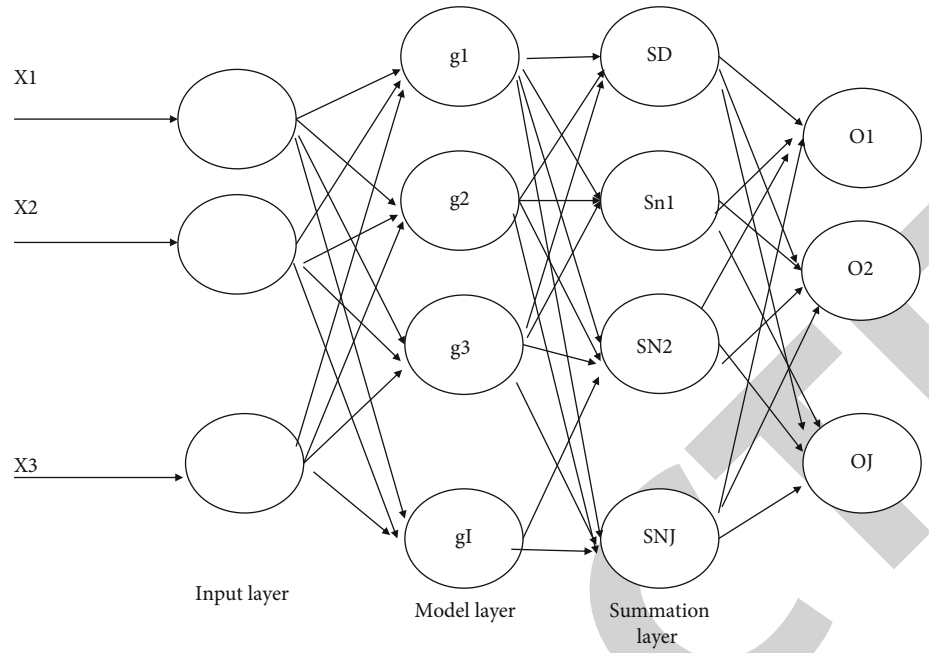

Figure 2: Generalized regression neural network structure diagram.

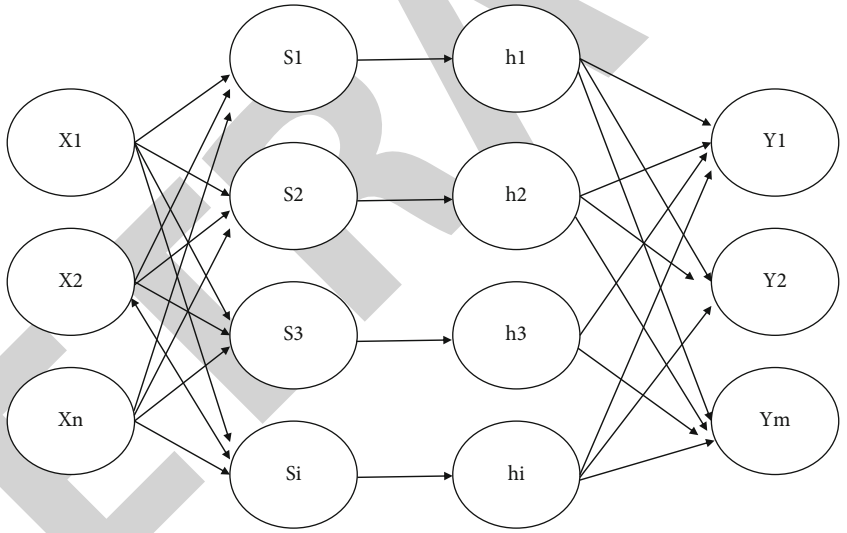

Figure 3: Wavelet neural network structure

on the energy consumption of assembled buildings, the external environment must be given priority consideration. It covers a wide area of Chengdu, Shanghai, and other major cities, and covers areas with different climatic characteristics and different climate characteristics. Since the thermal environment varies, the requirements for the construction and design of houses in different environments will be different, and thus, the laws of research will be different.

3.4.2. Overview of Energy-Saving Factors of Building Envelope Composition: Take the Western Sichuan Plain Area as an Example. In general terms regardless of the existence of the meaning are to stop all the external adverse factors caused by the cause of indoor problems. There are five parts: wall, door, door window, top, and bottom. It can be seen that the type of peripheral structure and the effectiveness of the thermal work are the entry points of the building energy-saving control, and the study of the peripheral structure is indispensable in order to achieve higher efficiency. The relevant calculation formulae are as follows.

(1) Average heat transfer coefficient of the envelope unit (considering the effect of thermal bridges)

$$K_m = K + \frac{\sum \psi_j l_j}{A}, \tag{1}$$

$$K = \frac{1}{R_0}, \tag{2}$$

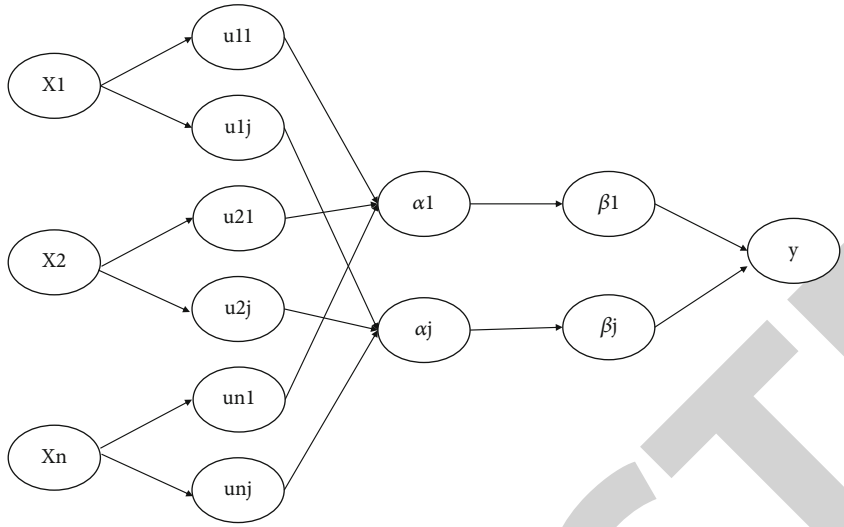

Figure 4: Fuzzy neural network.

where R_0 is the heat transfer resistance of the enclosure (m^2-K/W); K is the heat transfer coefficient of the flat wall of the enclosure; ψ_j [W/(m-K)] is the line heat transfer coefficient of the jth structural thermal bridge on the enclosure [W/(m-K)].

Heat transfer resistance of the flat wall of the enclosure structure:

$$R_0 = R_i + R + R_e, \tag{3}$$

where R is the thermal resistance of the material layer (㎡-K/W); R_i is thermal resistance of the inner surface (㎡-K/W), taken according to the specification; and R_e is the thermal resistance of the outer surface (㎡-K/W), taken according to the specification.

$$R = R_1 + R_2 + \cdots\cdots + R_n. \tag{4}$$

Flat wall thermal resistance of the envelope of multilayer construction materials:

The thermal resistance of single-layer materials:

$$R = \frac{\delta}{\lambda}, \tag{5}$$

where δ is the thickness of the material layer (m) and λ is the thermal conductivity of the material [W/(m-K)], according to the normative value.

(2) Multilayer construction materials of the envelope flat wall thermal inertia indicators:

$$D = D_1 + D_2 + \cdots\cdots + D_n. \tag{6}$$

Thermal inertia indicators of single-layer materials:

$$D = R \cdot S. \tag{7}$$

Thermal storage coefficient of the material:

$$S = \sqrt{\frac{2\pi\lambda c\rho}{3.6\mathrm{T}}}. \tag{8}$$

4. Results and Discussion

4.1. Research Methods and Tools. This paper is mainly to study the impact of different materials of the building envelope, mainly the exterior window insulation, on the energy saving of the building, and adopt OpenStudio software for different data to simulate the study, and the simulation will establish the simulation test for different materials with their corresponding values.

4.1.1. Primary and Secondary Variables. Since the experimental study mainly focuses on the envelope of the assembled building, and the outer wall of the assembled building has the largest contact range with the outside air and affects the energy consumption more strongly, its thermal performance is especially significant for energy consumption. In addition, the good or bad thermal performance is mainly related to many factors, so it cannot simply consider one aspect of the factors. The study for the insulation of the material thickness as the main variable, and the integration of China's often used four kinds of window materials and insulation materials as auxiliary variables.

4.1.2. Setup of the Simulation Process. Referring to the results of previous studies by foreign scholars, the base model here is always taken as a $15 \times 4.8 \times 3$ m base model, and the first step is to use the software for simulation to work out the simulated values. In the second step, the graphs of the corresponding changes are edited according to the values. The data analysis software is used to make measurements, algorithm-related formulas, and program applications, and finally draw conclusions, and provide reference recommendations.

4.1.3. Neural Network. Neural network is essentially a nonlinear predictive model, as its name suggests, an algorithm that imitates the human and animal nervous system for computation. It is based on imitating the neural network system of human and animal brain, performing computations, and then processing the content of each module. Neural network algorithm is a derivative of data mining technology, which is one of the types of data mining technology that can be used for big data mining, such as analysis, classification, aggregation, and other data mining functions. Its advantages and disadvantages are very clear, the first advantage is that it is extremely resistant to interference, and the second is that it is capable of deep learning and better memory in a nonlinear situation, and can handle more complex situations. At the same time, it has two disadvantages: The first is that its computation and processing results are low-dimensional and cannot be adapted to high-dimensional environments, so it has a hard-to-interpret nature. The second is that both supervised and unsupervised learning require a long learning time, and data collection is done using the more traditional neural network approach.

Other kinds of algorithms require relevant mathematical mapping relations. The artificial neural network algorithm involved in this paper does not require a large number of mathematical mapping relations, so it does not need to input a large number of mathematical equations in the first place, because it needs to be able to learn some other basic mathematical rules systematically through training on the data in advance, so that it can output the required mathematical calculation results better and simulate the mathematical model better given certain function values and mathematical function values. As a complex discipline in computer science and mathematics and statistics, one of the main core functions of artificial neural network is training algorithms for mathematical calculations and information statistics.

The basic algorithm theory BP algorithm theory process mainly includes the process of linear propagation of the output signal deviation forward and backward and the process of linear propagation of the output signal error forward and backward and reverse which are two process calculation processes. That is, the signal error can be adjusted according to the two input directions from the actual input signal direction to the actual expected signal output, respectively, to calculate the signal output, from the direction of the real expected signal output and then to the real expected input direction of the two directions, respectively, to calculate the signal error to adjust the signal error weight range and error threshold. In the study of the propagation method after the forward superposition of the signal, the input node signal is mainly the node on the actual output of the signal after the inverse superposition through the role of the hidden layer, and the actual output node signal can be generated through the nonlinear transformation process. If we find that the actual signal output node position is not consistent with the actual input node expectation signal of the actual output node direction position, it will be easy to produce the process of backward feedback propagation method for signal error compensation. The principle of error input signal back propagation processing system is that the system will automatically back propagate its various output signals or error information values to each error input layer of the system through the hidden layer nodes layer by layer, and will sequentially transfer its output error signal values to the nodes on each layer corresponding to all other layers of the system error input signal elements, with the system in each layer of the system nodes obtained The output error input signal values obtained by the system at each layer node are used as the basis for its calculation to automatically adjust the weights among the error output signal elements of the system.

In this paper, in addition to the three neural networks introduced in Section 3, radial basis neural networks are also used. The last type is radial basis neural network (RBFNN for short). It is more convenient because it has only three layers, in addition to having supervised learning and unsupervised learning data processing like traditional neural networks. Secondly, it has a better statistical basis, it is a linear computation, and then, he can pass to the next layer after data processing by function. After three layers of computation, the output results are obtained. In the case of camera neural network, it outputs data mainly through two layers of algorithms, and the specific computation is supervised learning and unsupervised learning, respectively. In the place of supervised learning, he needs to perform clustering algorithm and analysis of some relevant data for clustering to figure out the required width value and the required neural network result.

4.2. Types of Factors Affecting the Energy Efficiency of Assembled Buildings

4.2.1. Types of Assembled Buildings. The Energy Conservation Design Standard for Residential Buildings in Hot Summer and Cold Winter Areas (JGJ134-2010) takes the perspective of energy conservation and classifies the building types of general residents in order to achieve the control of the whole building system as well as the coefficients. For example, 1 ~ 3-story residential buildings are basically villas, 4 ~ 11-story buildings are mainly slab-type structures, and domestic 12-story and above buildings are basically high-rise tower-type buildings.

4.2.2. Building Plan Form. For the energy consumption of the building, the energy consumption of the square plane traces is larger, while the energy consumption of the rectangle is relatively small. The regularity of the building plan determines the energy consumption of the whole house, and generally speaking, the more regular the pile of housing types such as ellipse or circle, the better the energy saving of the house, and the energy consumption will tend to a certain fixed value.

4.2.3. Building Window-to-Wall Ratio. Generally speaking, the area ratio of exterior windows is positively related to the seriousness of energy loss, and it is difficult to control energy loss when the area ratio of exterior windows is larger. Therefore, the study of window-to-wall ratio, especially the exterior windows, is the most important and cannot be ignored for the energy consumption of buildings. The

development of buildings in China tends to pursue the neatness and openness of the whole roof, so the window-to-wall ratio is increasing, but in contrast, the energy-saving requirements have not been met, and the energy loss has gradually become a point that cannot be ignored. However, in general, it is desirable to increase the ratio of external window area for the comfort of the house.

4.2.4. Building Body Coefficient. According to the relevant building code system coefficient of presentation, in the building number of floors below three and below three, the coefficient of body shape cannot exceed 0.55; after the building between 11 and 4 floors, the body shape factor cannot exceed 0.40; for high-rise buildings above 12 stories, a building system number less than 0.35 is reasonable. The shape factor of the building depends on the size of the plane, the height, and the shape of the plane. The relevant factors are determined by the length and width of the building, so the focus should be on controlling the size and depth of the building in the design stage.

4.2.5. Building Maintenance Structure. As the main envelope of the building, windows, roof, walls, and floors, especially the external windows, the energy loss is basically in the external windows. The literature review on buildings has shown us that the energy loss is basically lost through the outer structure. In order to explore the energy-saving factors of buildings, the relationship between the thermal performance of the envelope and the way it is constructed and the energy consumption must be clear. The energy efficiency of a building is basically influenced by the material of the envelope structure. The heat and energy consumption of exterior windows and walls are at the highest level, so to improve the insulation performance of both will be of great help to the energy saving of the whole building. In China's cold winter and hot summer areas such as the assembly buildings in the Sichuan West Plain, the exterior walls again occupy a huge proportion of the entire exterior envelope, and in addition, the exterior envelope is also an important factor in energy loss.

4.3. Analysis

4.3.1. Parameter Setting. According to China's residential design code, the model adopts a $15 \times 4.8 \times 3$ m rectangular simulation model as the basis of the energy consumption simulation study in this paper and strictly restricts the data to the numerical values. The window-to-wall ratio is set to 0.3 to the north, 0.5 to the south, and 0.35 to the east-west.

The final form of the perimeter wall structure and the selection of materials in this study were analyzed and set in accordance with the relevant standard regulations and the survey data, and the sandwich composite panels of reinforced concrete were selected. The sandwich precast exterior wall structure was decorated from the outside to the inside. The external decorative layer is mainly crushed concrete: The internal leaf wall panel is set at 200 mm, and the lime mortar is set at 15 mm as the thermal analysis sample of this external wall. XPS, EPS, PU, and phenolic are used as insulation materials.

4.3.2. Research and Analysis of Heating and Air Conditioning. In the study of the thermal performance of the external wall, the thickness of the insulation layer grows from 20 mm to 100 mm with a growth rate of 5 mm; the thickness of the insulation layer is set as the main variable; and XPS, EPS, PU, and phenolic as insulation materials are set as auxiliary variables.

(1) The use of neural networks and the use of OpenStudio software to explore the XPS as the insulation material when the base model for different windows in the use of different insulation thickness of the exterior wall heating and air conditioning load exploration, the data are as follows: the study selected four windows for the thickness of impractical insulation material for heating and load exploration, the data can be seen when the XPS insulation material thickness is greater, and the building year-round heating and air conditioning and load are decreasing trend, proving that the higher the thickness of the building's insulation, the smaller the load, more energy efficient and environmentally friendly, as shown in Figure 5

(2) Exploring the simulation of energy consumption when EPS is used for exterior wall insulation, the thickness of the insulation layer grows from 20 mm to 100 mm in sequence, resulting in a simulation test analysis of energy consumption of exterior walls with different window types see combinations. The thickness of the insulation layer was increased from 20 mm to 100 mm in sequence, so as to simulate and test the analysis of the energy consumption of the facade for different window types. The data analyzed are as follows: Four types of windows were selected for this study to explore the energy consumption of the facade. It can be seen from the data that when the thickness of the insulation material is larger, the energy consumption of the building's heating and air conditioning facade throughout the year is on a downward trend, proving that the higher the thickness of the building's EPS insulation layer, the smaller the energy consumption of the facade, the more energy-efficient and environmentally friendly it is, as shown in Figure 6

(3) When the insulation material of the building's exterior wall using phenolic/PU, the thickness of the insulation layer is set to 20 mm to 100 mm; exploring the energy consumption of various buildings under different windows simulation test analysis and exploring the material of the exterior wall insulation layer using phenolic/PU, the thickness of the insulation layer is set to 20-100 mm still, after exploring the building under different window types of the exterior wall energy simulation test analysis as shown in Figure 7

4.3.3. Simulation Study of the Total Load of Annual Energy Consumption Heating and Air Conditioning. Numerical simulation of the total load of heating and air conditioning of the base model under different heat transfer coefficients with different types of insulation materials are taken for the exterior

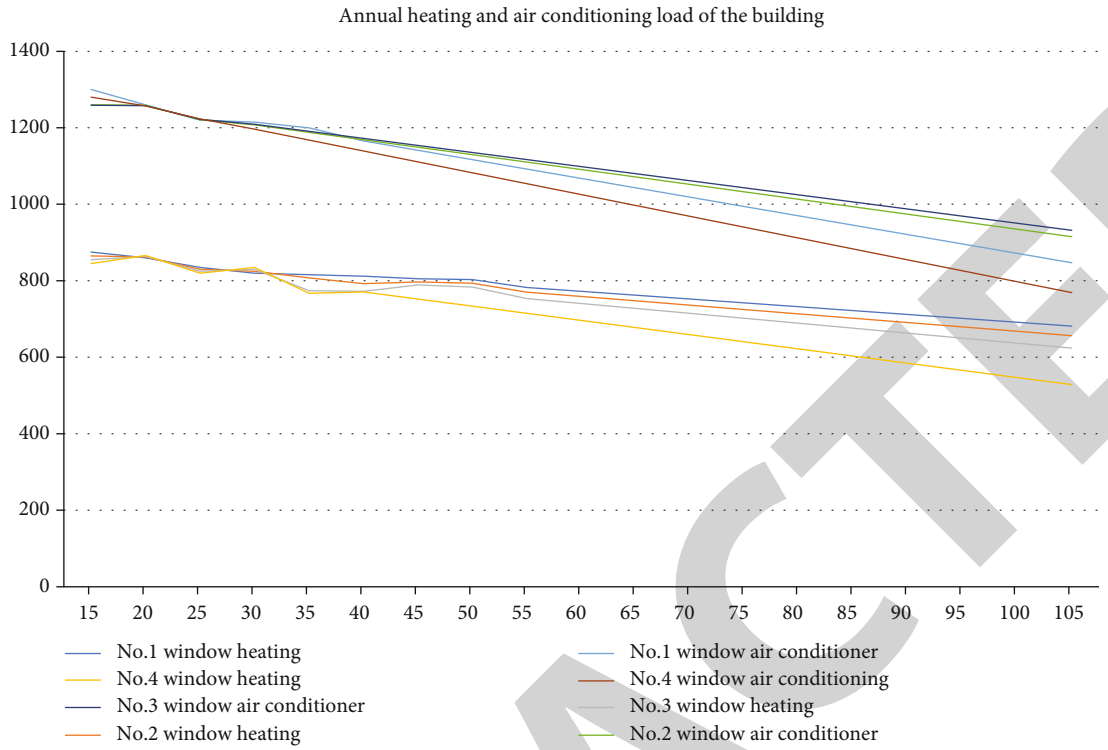

Figure 5: Building year-round heating and air conditioning load volume, XPS.

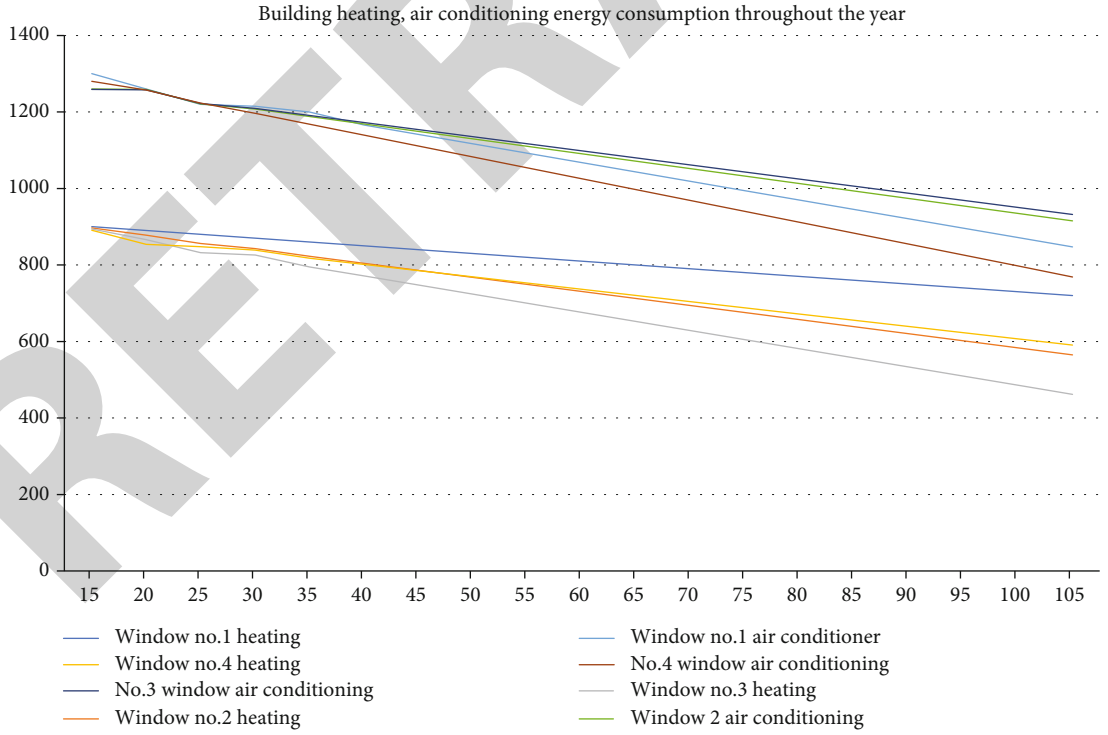

Figure 6: Building year-round heating, air conditioning energy consumption, EPS.

wall as an example of window number one. The insulation thickness takes the value range 20~100 mm, the market material supply, so take 5 mm as the difference. Window No. 1 (6+9A+6) is selected to establish the model of exterior wall insulation material such as XPS, EPS, and phenolic/PU for the annual energy consumption simulation, as shown in Figure 8.

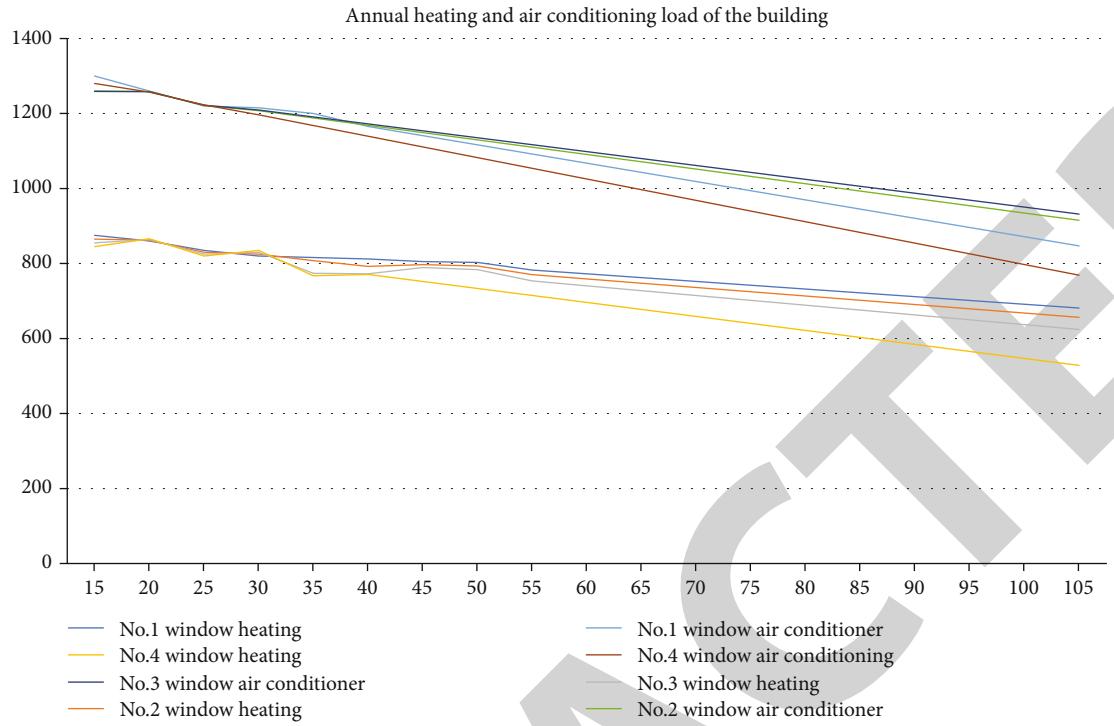

Figure 7: Building year-round heating and air conditioning energy consumption, phenolic/PU.

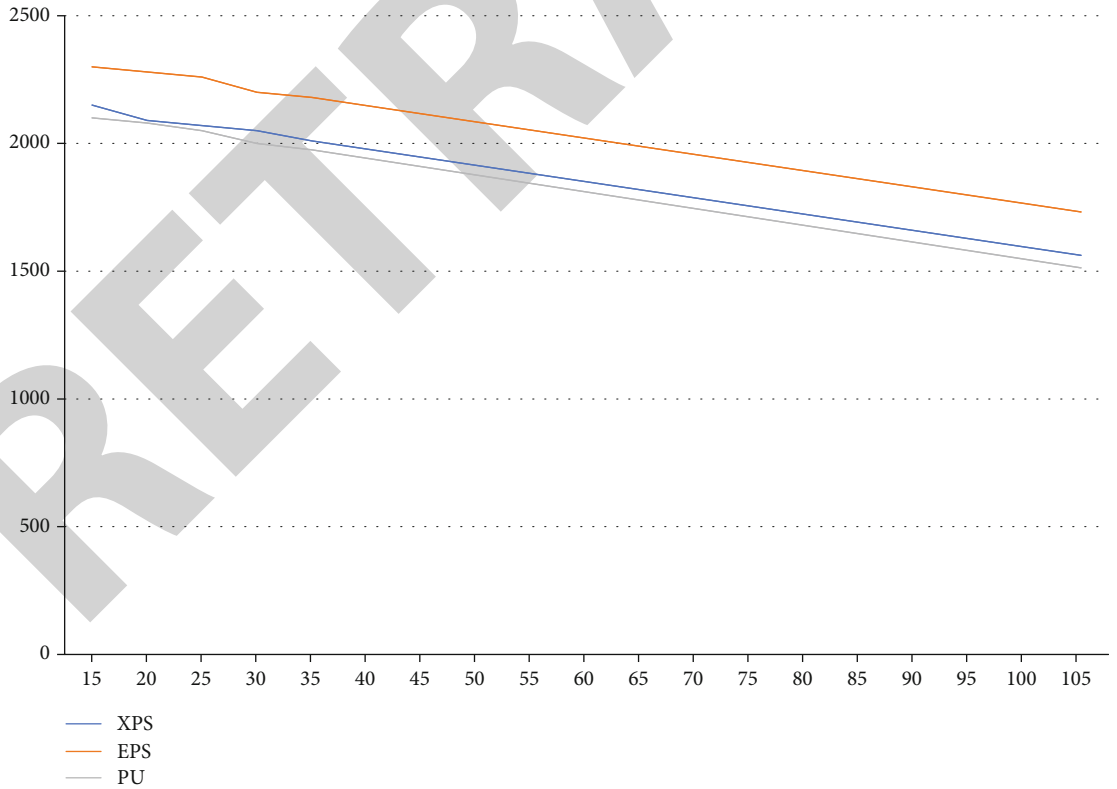

Figure 8: Relationship between insulation thickness and total heating and air conditioning load curve.

4.3.4. Multifaceted Analysis of Univariate Factors. With the external environment unchanged, SPSS software was used to conduct a multifaceted ANOVA on a single variable for the insulation thickness of the building's exterior walls and for different window types, so that the degree of influence of these two factors on the total air conditioning load could be distinguished.

4.4. Results. It can be concluded that the material coefficients K heat transfer coefficients of the building's exterior wall construction vary with different thicknesses of the insulation layer. As the material K values change, the building's energy consumption simulations behave similarly, and only the coefficients of heat storage and density have small differences, which lead to the same values of the experimentally simulated loads.

The simulation of heating and air conditioning loads using OpenStudio software is mainly applied to the base model of XPS-based insulation materials when different insulation thicknesses are taken in turn for the external walls. It is not difficult to find that, despite the increasing thickness of the insulation layer, the amount of load shows the opposite trend of reduction, most notably because the impact of different window types bucket air conditioning heating is small. Outdoor heat transfer capacity is determined by the thickness of the insulation layer, the thickness of the insulation layer from 20 mm began to grow to 100 mm in the process, the insulation layer is getting thicker and thicker, and the heat transfer capacity also decreases. It can be concluded that the thickness of the insulation layer and the heat transfer capacity show an inverse trend between the heating and air conditioning load is the same as the trend of change between the heating and air conditioning load, as the thickness of the insulation layer continues to increase, and the heating and air conditioning load are showing a continuous reduction but the rate of reduction in the shrinking trend. But all in all, compared to the decreasing trend of air conditioning, load heating energy consumption decreases and has a greater impact, while for heating load, the impact is smaller, and the cooling effect is stronger. Different window types have a smaller impact on the heating and air conditioning loads of the building, and the graphical trend is basically the same as XPS and EPS when phenolic/PU is used as the insulation material for the building exterior. It can be concluded that the air conditioning heating energy intensity of the assembled building in the west Sichuan plain area shows a decreasing energy intensity with the increase of the thickness of the insulation layer instead, and the decreasing trend is shrinking.

We take the no. 1 window as an example to study the numerical simulation of air conditioning load when heating the foundation formwork under different heat transfer coefficients, and it can be seen that as the thickness of insulation layer increases, the total energy consumption of the building shows a decreasing trend, and the magnitude is also shrinking. Different insulation materials show a positive correlation with the energy consumption as the heat transfer coefficient K increases in the same environment. From the figure, it can be seen that the three curves maintain the same trend of change, and finally conclude that whether the thickness of the insulation layer increases or not, and the change of energy consumption of the building under different insulation materials will not be much different.

From the equation, it can be concluded that R^2 is 0.999, 1, and 1.0001 and the p value of its F-test is 0 less than 0.005 which can be concluded that it is dominantly correlated and the fit of the simulation is better.

$$q_{\mathrm{XPS}} = 2533.207 - 23.699h + 0.258h^2 - 0.001h^3, \tag{9}$$

$$q_{\mathrm{EPS}} = 2566.490 - 19.818h + 0.186h^2 - 0.001h^3. \tag{10}$$

$$q_{\text{酚醛/PU}} = 2416.930 - 21.132h + 0.223h^2 - 0.001h^3 \tag{11}$$

The trends of the three curves of the fitted functional equation remain consistent in general.

5. Conclusion

This paper takes assembled buildings in the west Sichuan plain area as the research object, based on dozens of assembled building enterprises researched, selected samples of the studied envelope components, selected BIM technology for premodeling optimization, used neural network algorithm for the analysis of influencing factors, studied the application in the study of energy-saving optimization of the assembled building envelope in the west Sichuan plain area, and used OpenStudio to establish model to simulate the heating and air conditioning load of the assembled building numerically and fit the variable factors to quantify the building energy consumption. This paper first read the relevant literature to summarize the analysis methods of building energy consumption, researched and collected dozens of production schemes of assembled buildings, considered numerous complex influencing factors and various environmental situations, and finally decided to use OpenStudio as the analysis software, after which the corresponding data were derived and drawn according to the settings and restrictions of model parameters, considering different window types and insulation layer thickness materials. The relevant graphs were drawn. Afterwards, SPSS software was used to analyze the influence of various variables on the energy consumption of the building. The influence of covariates on building energy consumption and the quantitative relationship equations between variables and building energy consumption were summarized. Suggestions for optimization were made.

Data Availability

The dataset is available upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Retraction

Retracted: Risk Assessment and Analysis in Supply Chain Finance Based on Blockchain Technology

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] X. Meng, "Risk Assessment and Analysis in Supply Chain Finance Based on Blockchain Technology," *Journal of Sensors*, vol. 2022, Article ID 1985803, 11 pages, 2022.

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Research Article

Risk Assessment and Analysis in Supply Chain Finance Based on Blockchain Technology

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With the development of the times, the financial industry is constantly changing. Blockchain technology continues to play an important role in supply chain finance. The security of the financial industry is very important. Blockchain technology can better protect the security of the financial industry, but there are also some risks. We have made a detailed investigation and research on the risk assessment and analysis of blockchain technology in supply chain finance. The research is as follows: (1) the risks under blockchain technology are introduced in detail, and the risks in many aspects are detailed. It is convenient for the public to do a good job in risk control in the use of blockchain finance. (2) The algorithm of the blockchain is used for mining. In finance, the security of privacy is the most important. The differential privacy in the algorithm and the Bc-ppkCa algorithm makes the financial privacy under the blockchain better. It is beneficial for the public to use blockchain technology more efficiently and safely. (3) The financial industry under the blockchain is very complex. Let us take the financial situation under industrial enterprises as an example. Investigate the company's supply chain financial situation data, and compare the advantages of supply chain finance and the company's financial situation. It also evaluates the risks generated by supply chain finance and makes corresponding analysis.

1. Introduction

In order to be able to fully exploit the key role of the new blockchain technology in supply chain financing, supply chain financing has developed into one of the hotspots in the application of blockchain technology. This article analyzes and discusses supply chain finance risk and proposes a new method of managing supply chain finance risk based on blockchain technology based on the characteristics of blockchain technology. It is aimed at improving the level of financial risk management and control in the supply chain, highlighting the great role of blockchain technology in supply chain risk management, and better developing financial services in the supply chain for the real economy [1]. Assess supply chain finance risks, account for claims, use evolutionary game methods to analyze factors affecting supply chain finance participants, and create supply chains for evolutionary game models in financial firms. SMEs and financial institutions analyze blockchain mechanisms for managing financial risks in supply chains and compare changes in development and sustainable development strategies before and after blockchain technology adoption. The strict regulatory environment created by blockchain technology means that SMEs and key companies are at greater risk at all times. SMEs will choose not to make repayments regardless of the profit margin achieved through cooperation and will effectively address the paradox that SMEs cannot obtain credit from financial institutions while increasing the ability to comply. Then, the evolutionary game between financial institutions and SMEs is balanced by financial institutions using business applications, SMEs adhere to contracts, and the convergence effect is better. Therefore, blockchain technology not only reduces the financial risk of financial institutions but also helps to solve the financial problems of small- and medium-sized businesses [2]. The purpose is to create a conceptual framework for blockchain-driven supply chain finance solutions. This framework is intended to facilitate coordination between buyers and sellers. In addition, it reduces inefficiency in implementing discrete financial instruments in the supply chain,

such as reverse factoring and dynamic discounting. In addition, the value drivers of blockchain technology are introduced, and their uniqueness in supply chain financing applications is explained. Although blockchain is considered a groundbreaking financial technology, there is very little research on its impact on supply chain financing. Therefore, on the basis of the latest technological innovations, contribute to the future development of supply chain financing [3]. The undermining and innovation of the Internet have led to supply chain financing moving towards the Internet, i.e., financing of the Internet supply chain. This document assumes that the main part of the Internet supply chain is diversified and that individuals are involved in the financing of the Internet supply chain, from financial institutions, key companies, to upstream and downstream SMEs and logistics companies, with a focus on large-scale Internet supply chains. The financial model and related risk factors have been demonstrated, with regard to the risk factors, the mechanism of use and the framework for blockchain technology in financial risk management of the Internet supply chain, and the method for financial risk management of the Internet supply chain based on blockchain technology [4]. Based on blockchain technology, all participants in the supply chain establish a consortium blockchain to form an ecosystem. In this consortium blockchain, all participants can perform operations such as supply chain finance and targeted marketing. The supply chain based on blockchain solves the problem of credit endorsement of core enterprises, establishes a shared alliance platform, intelligently adjusts the remaining credit limit, realizes payment and settlement on time with the help of smart contracts, and strengthens management. Blockchain-based supply chain finance simplifies the application process, promotes credit and credit reporting-related businesses, and improves the social and economic benefits of this system [5]. With the improvement of supply chain financing, the credit risk of supply chain financing for small- and medium-sized financial enterprises has become apparent. Risk management is one of the main tasks when borrowing from banks and other financial institutions and goes through all the stages before, during, and after borrowing. An ambiguous neural network algorithm is used to process financial data and assess risk, effectively addressing and improving risk management in the supply chain [6]. Blockchain (BCT) promises to change the way individuals and businesses exchange value and information online and is well placed to facilitate a new level of collaboration between players in international supply chains. The book discusses how BCT can facilitate supply chain financing (SCF) initiatives, as the authors consider SCF to be another leading provider of financial services to improve supply chain cycles [7]. Blockchain can provide persistent, shared, and verifiable product records throughout the supply chain, improving product traceability, authenticity, and legitimacy in a more cost-effective manner. This section discusses the potential expectations for agribusiness development using blockchain technology. A case designed for car production is also presented: a micro factory using blockchain technology [8]. Supply chain financing has made a significant contribution to the financing and development of SMEs in recent years. However, due to problems in the supply chain system itself, the development of supply chain financing has stalled. The state of supply chain financing and the development of the blockchain+supply chain financing platform are analyzed. In response to the platform's challenges, the blockchain-based financial supply chain platform was creatively divided into four modules: authorization management, credit management, contract management and traceability, further design optimization, and full use of technical functions and authentication. In order to expand transactions and data exchange, supply chain financial services achieve full coverage of the supply chain. Finally, following an analysis of the platform's potential risks, appropriate proposals are put forward [9]. Develop a new blockchain technology information security management system that is not currently available in national and international information security standards. Key facts: blockchain technology is a secure, relatively new technology in a distributed digital book, based on interconnected blocks of operations, providing great benefits such as decentralization, transparency, consistency, and automation. The adoption of blockchain technology is growing rapidly in a variety of solutions and applications around the world and in a variety of industries such as finance, supply chain, digital identity, energy, healthcare, real estate, and government sectors [10]. Blockchain, as the core bitcoin technology and structure, consists of credit and credit processing systems and is characterized by decentralization, unreliability, anonymity, and unnecessary data manipulation. Big data online supply chain financing not only brings unique financing benefits to small, medium, and microenterprises but also poses new operational and regulatory risks. The application of blockchain technology in online supply chain financing through the coordinated development of blockchain and online supply chain financing is essential to prevent and control the risks of online supply chain financing. However, as a new technology, blockchain technology is still in the research phase and faces many challenges, such as building block hardware infrastructure, professionals, and consensus mechanisms [11]. Through the continuous and consistent implementation of the Internet+development strategy, supply chain financing using Internet technologies is gradually becoming the most important way of financing small- and medium-sized businesses. The close integration of supply chain financing with real industries and finance has made a significant contribution to the continuous improvement of supply chain actors, especially SMEs. Integrating blockchain components and attributes into different supply chain financing application chains can effectively address the SME financial supply chain financing dilemma [12]. Investigate the role of blockchain technology (BCT) in supply chain management (SCM), with a particular focus on interorganizational and customer confidence in the product. The following sections, arranged topologically, deepen the role of technology in supply chain management. This report begins by defining supply chain management from an overall perspective and then focuses on the elements that make up the basic principles of supply chains, namely, the flow of information, materials, and cash. Compare the functions of

BCT with the elements of SCM and create a system that reveals the areas where technology plays a key role. The application of the method in the field of maximum convergence is further analyzed through case studies and reviews of scientific articles. Propose a data architecture in which BCT could play its role in supply chain management while ensuring that only sensitive parties in the relevant value chain could see sensitive company information [13]. Businesses around the world, and more specifically today, are moving to digitize and eliminate time-consuming processes. As knowledge of the origin and security of products become increasingly important in building end-user confidence, traceability solutions are urgent. Blockchain (BC) is one of the most exciting technologies today. The aim of the study was to analyze the possibility of using BC to fully monitor supply chain management and to provide guidance on the application of BC to fish monitoring and control in the supply chain environment [14]. Blockchain provides a secure and reliable guarantee for information transactions. Business partners share information and interests, as well as share risks, which has led to integration into a chain of blocks. However, the biggest challenge of this integration may be building trust. The proposed solution is to create a supply chain financial services system based on the consortium blockchain. When SMEs need financing, they can effectively obtain a loan through a blockchain system. Thanks to the consensus mechanism and encryption technology in the supply chain, the system provides more convenient methods for controlling and monitoring financing for companies, banks, and regulators and speeds up financing for ancillary companies. At the same time, the system makes the financing process transparent, secure, and traceable. On the one hand, the system changes the way information is stored in a chain of blocks from the relevant SME systems. On the other hand, regulators can effectively monitor the actual use of credit by SMEs. This partly addresses the financial difficulties of SMEs [15]. For the supply chain finance in the blockchain application scenario, the above literature holds that blockchain technology has many other incomparable technical characteristics, while the traditional supply chain finance model still has many problems, and blockchain technology can solve the existing problems pertinently and, to a certain extent, carry out early warning and effective control of many risks in the supply chain financial operation process. In view of the fact that the content of risk assessment and analysis is relatively small, this paper analyzes the risk behavior in the blockchain.

2. The Main Risks of Blockchain Technology in Supply Chain Finance

2.1. Security Issues. Security risks for blockchain applications include significant data breaches and key loss. Every participant must have access to all transaction data, and even some sensitive information must be made public. In addition, the encryption technology used in blockchain is immature and does not have a certain level of privacy protection, which makes some sensitive information easy to leak. Public keys represent identity in blockchain technology, and its security is the foundation of trust. The private key belongs to each user, ensuring the security of digital property, and its loss will cause huge economic losses and damage to the owner's interests. Furthermore, the loss of keys makes these losses irreplaceable due to the uniqueness of the keys and the lack of a private key reissue mode. It is shown in Figure 1.

2.2. Credit Risk of Core Enterprises. In supply chain finance, the main player is the leader who brings relevant players together and engages them through solidarity created by specific common interests. It occupies a key position in the supply chain. Other companies in the supply chain are hub companies. The company is the center of logistics, capital flow, and information, around which the production activities of the hub company are organized. Based on the evaluation of the creditworthiness of large companies, the authenticity and risk of transactions, and the overall reliability of the supply chain, financial institutions provide financial services, assets, liquidity, and financial services to related companies in the chain around large companies in key supply chain companies facing serious credit crises, credit impact, cash flow, and other risks; relevant small- and medium-sized enterprises and small and microenterprises will be affected; and the cash flow of the entire supply chain will be blocked. The credit risk of key enterprises will be distributed throughout the supply chain, and the supply will threaten the overall security of online financing.

2.3. Performance Issues and Latency. In terms of performance and scalability, since the data storage capacity of each block is limited, if the transaction data gradually increases, the system traffic and storage capacity of nodes will be extremely difficult to manage. Expanding the management of large operations poses significant risks to supply chain financing and, secondly, the issue of latency. Blockchain technology delays transactions because the more consensus-level nodes used to fund the supply chain and the longer it takes to validate data, the more efficient blockchain financial transactions are. Blockchain+supply chain may rely on Internet transmission, resulting in delays in technical transactions of blockchain. It is shown in Figure 2.

As can be seen from the relationship between supply chain financing and blockchain services in Figure 2, the main value of supply chain financing lies in optimizing the allocation of funds over time and space and supplementing with risk and efficiency sharing across time and space. Save value to balance supply and demand. Key companies have a strong say in most supply chains and usually do not use cash transactions for suppliers, but rather transactions with settlement times d. Because the blockchain itself is not controllable, the distribution is a cross-validation mechanism to verify the credibility of each node's business. Data is guaranteed, which solves the problem of identity credibility in financing and lending equity certificates and improves the ability to control the creditworthiness of financial institutions, which also reduces the complexity of controlling their risks significantly.

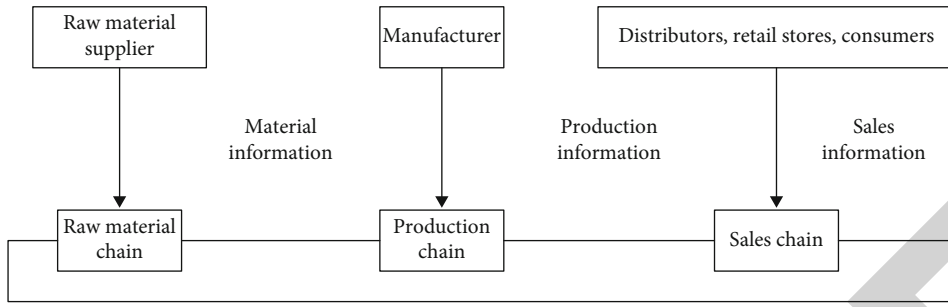

Figure 1: Blockchain applied to supply chain.

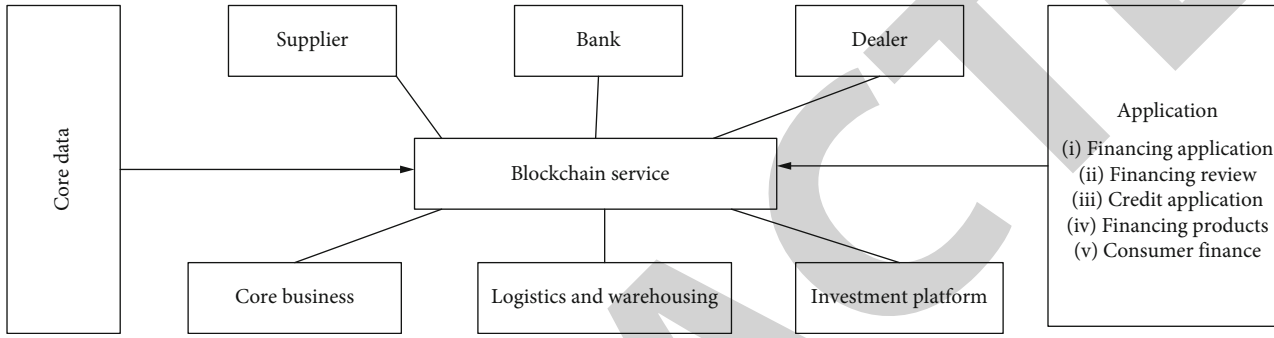

Figure 2: Supply chain financial performance services.

3. Blockchain Algorithm

3.1. Localized Differential Privacy. The basic definition of localized differential privacy is as follows:

Given m users, each user corresponds to a record. If the privacy algorithm F, for any two input records $m_0, m_1 (m_0, m_1 \in DF)$, the same output result $m^* (m^* \in RF)$ satisfies the following inequality:

$$\Pr[F(m_0) = m_*] \leq e^{\varepsilon} \times \mathrm{pr}[F(m_1) = m_*]. \quad (1)$$

3.2. Immediate Response Mechanism. The random response mechanism is currently the main local differential data protection mechanism. To illustrate the rationale more clearly, here is a concrete scenario: I want to study the number of depressed people among n users, so I activate a privacy policy for each user. Deciding whether to answer the question by tossing a coin is true. Let the probability of the tail appearing be $1 - p$. When the ratio of the privacy budget to the probability p satisfies the following formula, local differential privacy is satisfied.

$$p = \frac{e^{\varepsilon}}{1 + e^{\varepsilon}}. \quad (2)$$

3.3. Differential Privacy. Differential privacy is increasingly applied in the fields of data sharing and data recovery. Compared with many other data protection methods, it is based on strict mathematical definitions, which can measure the level of data protection through parameters, ensuring that even if two data sets differ only in one element, the same query data set is performed on both elements, Algorithm A satisfies

$$\mathrm{pr}[A(D_0) \in S_A] \leq e^{\varepsilon} \times \mathrm{pr}[A(D_1) \in S_A]. \quad (3)$$

Differential privacy can be applied to machine learning, recommender systems, censuses, traffic information protection, and more. Google uses localized differential privacy technology to collect more than 14 million user behavior statistics from Chrome every day. Apple also uses localized differential private technology to protect the privacy of iOS/macOS users. Yisaitong, as a major company in the data security industry, recognizes the potential of privacy-friendly computer technology, which is expected to be widely used and has continued to increase its investment in research and development of differential computer privacy protection.

3.4. $M - kCCIA$ Algorithm. Take household expenditure as an example, such as $Y = ax_1 + bx_2 + c$+random error term represents household expenditure, represents household income, represents household wealth, and is a constant, that is, household basic consumption. At this time, the random error term represents GDP, consumer price index, industrial product price index, local currency exchange rate, commodity price index, average house price, average child education expenses, and so on. We know that income and wealth are more direct variables that determine household spending, so we introduce them into the model, and both macroeconomic conditions and price levels indirectly affect household spending.

In $M - kCCIA$, in order to protect the private data of each user, it is necessary to perform random perturbation processing on the private data of each user according to the random response mechanism, and the processing method is designed for $M - kCCIA$. For the p-bit, the probability formula of its perturbation value is as follows:

$$\Pr\left(\tilde{c}_{q,p}=1\right)=\frac{1}{2}f_{1,p}, \tag{4}$$

$$\Pr\left(\tilde{c}_{q,p}=0\right)=\frac{1}{2}f_{1,p}, \tag{5}$$

$$\Pr\left(\tilde{c}_{q,p}=c_{q,p}\right)=1-f_{1,p}. \tag{6}$$

Among them, the probability of $c_{q,p}(0\le p\le l\text{-}1)$ that the disturbance is the real value is $1-(1/2)f_{1,p}$, which is known from the theory of random response mechanism, that is, $f_{1,p}=(2/(1+e^{\varepsilon_{1,p}}))$.

In $M-kCCIA$, both the user and the blockchain know $f_{1,p}$. The user can evaluate the corresponding real value of each bit according to the existing perturbed binary strings $|c_q|=\{c_q,0,c_q,1,\cdots,c_q,l-1\}$ and $f_{1,p}$, and the calculation is as follows:

$$\tilde{c}_{q,p}=c_{q,p}\times 1-f_{1,p}+\frac{1}{2}f_{1,p}, \tag{7}$$

$$c_{q,p}=\frac{\tilde{c}_{q,p}-(1/2)f_{1,p}}{1-f_{1,p}}. \tag{8}$$

The corresponding decimal is

$$c_q=\sum_{p=0}^{l-1}\left(2^{l-p}\times c_{q,p}\right). \tag{9}$$

3.5. Bc – PPkCA algorithms. Input: the initial perturbed cluster center $\tilde{c}_1,\tilde{c}_2,\cdots,\tilde{c}_k$ is obtained from the blockchain; the data set $DO_1,DO_2,\cdots,DO_m$ of m users $\{d_{1,1},d_{1,2},\cdots,d_{1,n_1}\}\cdots,\{d_{m,1},d_{m,2},\cdots,d_{m,n_1}\}$, the privacy budget $\varepsilon_1,\varepsilon_b,\varepsilon_a$.

Output: clustering results.

(1) $M-kCCIA$ runs $\tilde{c}_1,\tilde{c}_2,\cdots,\tilde{c}_k$ to get

(2) Each user A obtains A from the blockchain, and each user operates

(3) According to the data owned by each user DO_i, locally calculate the attribute value of each class after the y-th iteration classification and $\mathrm{Sum}_{i,q,y}$ and the number of each class and $\mathrm{Num}_{i,q,y}(1\le q\le k)$

(4) Each user DO_i performs the following calculations:

$$\mathrm{Sum}_{i,q,y}=\left|\mathrm{Sum}_{i,q,y}\times 10\right|, \tag{10}$$

$$B_{\mathrm{Sum}_{i,q,y}}=\left\{b_{i,q,0,y},b_{i,q,1,y},\cdots,b_{i,q,l_1-1,y}\right\}, \tag{11}$$

$$A_{\mathrm{Num}_{i,q,y}}=\left\{a_{i,q,0,y},a_{i,q,1,y},\cdots,a_{i,q,l_2-1,y}\right\}, \tag{12}$$

$$\tilde{B}_{\mathrm{Sum}_{i,q,y}}=\mathrm{Random2}\left(B_{\mathrm{Sum}_{i,q,y}},\varepsilon_b,r_2^*\right), \tag{13}$$

$$\tilde{A}_{\mathrm{Num}_{i,q,y}}=\mathrm{Random3}\left(A_{\mathrm{Num}_{i,q,y}},\varepsilon_a,r_3^*\right). \tag{14}$$

Each user DO_i broadcasts the perturbed binary strings $\tilde{B}_{Sum_{i,q,y}}$ and $\tilde{A}_{\mathrm{Num}_{i,q,y}}$ to the blockchain

(5) Running the algorithm

Explain Random2 and Random3 used in Algorithm 3: m users $DO_1,DO_2,\cdots,DO_m$.

Their respective privacy budgets are $\varepsilon_b,\varepsilon_a$, where ε_b is the privacy budget of the sum of each type of attribute value in each iteration and ε_a is the privacy budget of the sum of the number of each class in each iteration. Each bit is perturbed by a random response mechanism. Then, the value of a_{i,q,j_a},b_{i,q,j_b} obtained by the disturbance of a_{i,q,j_a},b_{i,q,j_b} and its probability corresponding relationship are

$$\Pr\left(\tilde{a}_{i,q,j_a}=1\right)=\frac{1}{2}f_{a,j_a}, \tag{15}$$

$$\Pr\left(\tilde{a}_{i,q,j_a}=0\right)=\frac{1}{2}f_{a,j_a}, \tag{16}$$

$$\Pr\left(\tilde{a}_{i,q,j_a}=a_{i,q,j_a}\right)=1-f_{a,j_a}, \tag{17}$$

$$\Pr\left(\tilde{b}_{i,q,j_b}=1\right)=\frac{1}{2}f_{b,j_b}, \tag{18}$$

$$\Pr\left(\tilde{b}_{i,q,j_b}=0\right)=\frac{1}{2}f_{b,j_b}, \tag{19}$$

$$\Pr\left(\tilde{b}_{i,q,j_b}=b_{i,q,j_b}\right)=1-f_{b,j_b}. \tag{20}$$

Among them, the probability of $b_{i,q,j_b}(0\le j_b\le l_1-1)$, $a_{i,q,j_a}(0\le j_a\le l_2-1)$ disturbance being the real value is $1-(1/2)f_{b,j_b}$, $1-(1/2)f_{a,j_a}$, respectively, and it can be known from the theory of random response mechanism:

$$1-\frac{1}{2}f_{b,j_b}=\frac{e^{\varepsilon_{b,j_b}}}{1+e^{\varepsilon_{b,j_b}}}(0\le j_b\le l_1-1), \tag{21}$$

$$1-\frac{1}{2}f_{a,j_a}=\frac{e^{\varepsilon_{a,j_a}}}{1+e^{\varepsilon_{a,j_a}}}(0\le j_a\le l_2-1), \tag{22}$$

which is

$$f_{b,j_b}=\frac{2}{1+e^{\varepsilon_{b,j_b}}}(0\le j_b\le l_1-1), \tag{23}$$

$$f_{a,j_a}=\frac{2}{1+e^{\varepsilon_{a,j_a}}}(0\le j_a\le l_2-1). \tag{24}$$

4. Investigation and Research on Supply Chain Finance under Blockchain Technology

4.1. Definition of Supply Chain Finance. Supply chain financing is the link connecting connect the enterprise, that is, large- and medium-sized enterprises and core enterprises. Complete financing, loans, etc., through supply chain financing. Shenzhen is China's economic development zone and the place where my country's supply chain financing

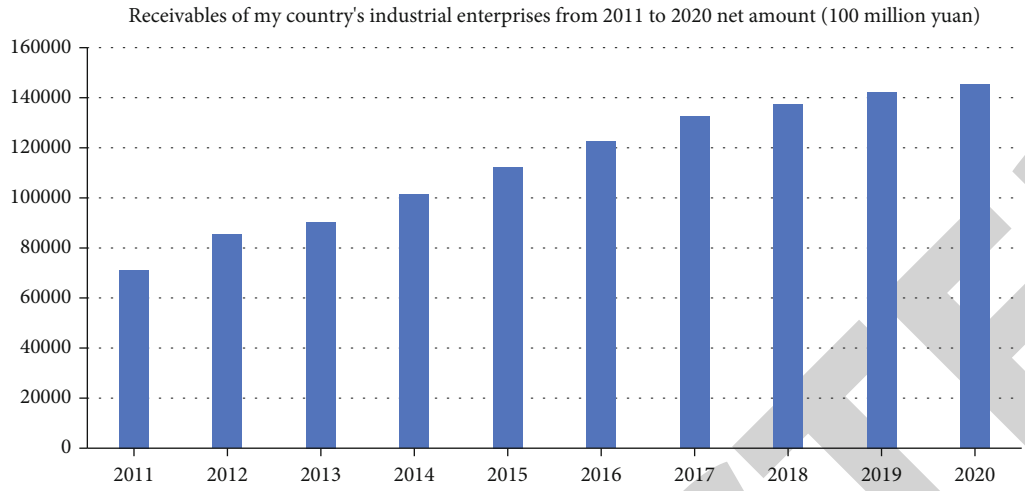

Figure 3: Net receivables from industrial enterprises in my country from 2011 to 2020.

was first born. It entered the field of supply chain financing through "discount account" transactions. Business enterprises in my country are the most important link in supply chain financing, because the main basis for corporate financing is the valuation of receipts and deposits. Studying the development of accounts receivable and net inventory of industrial enterprises in my country in the past ten years will help to establish a supply chain financing system in an all-round way. It is shown in Figure 3 and Table 1.

According to the data of the National Bureau of Statistics of China, the net accounts receivable of industrial enterprises in my country from 2011 to 2020 increased rapidly from 8,023.167 billion yuan in 2011 to 13,612.448 billion yuan in 2020 and showed an upward trend, with a growth rate of about three times. This shows that the doubling of the net claims of industrial enterprises in the past decade is an important prerequisite for the continuous expansion of my country's financial market in the supply chain. It is shown in Figure 4 and Table 2.

According to the statistics of the National Bureau of Statistics of China, my country's industrial inventory is increasing day by day and has increased by 2.4 times in ten years. This shows that the productivity of my country's industrial enterprises is continuously improving, and the financial supply chain market is developing well. It is shown in Table 3.

The research of domestic and foreign scholars mainly focuses on the application effect, risk prevention and control, and some industry fields, and there are few system construction and analysis on the blockchain supply chain finance. This paper briefly describes the advantages of supply chain finance and the perspectives of chain code implementation and privacy protection to build a system template for blockchain technology in supply chain finance to enhance the security and processing efficiency of blockchain financial technology. The application innovation has strong reference value.

4.2. Hotspot Analysis of Blockchain Theme Research. A research topic reflects changes in the research perspective and research focus of a particular field over a certain period of time. Keywords can be a good representation of the topic of the article. Keyword occurrence and cluster analysis help capture the changing trends of popular keywords. Time view provides guidance on how to track research trends in the field. "Blockchain," "blockchain technology," "industry chain," and "blockchain finance" are the four major clusters. The quality of clustering is usually determined by two indicators, one of which is the value of the clustering module (modularity); usually the higher the value, the better the clustering effect. The next one is the mean of the cluster contours. When $S > 0.5$, the clustering is considered reasonable. The closer the value is to 1, the higher the network homogeneity. The clustering results of the test objects show that $Q = 0.8489$ and $S = 0.9767$; the clustering results are good and reliable.

Table 1: Net receivables from industrial enterprises in my country from 2011 to 2020.

Net receivables from industrial enterprises in my country from 2011 to 2020	
2011	71221.67
2012	85334.78
2013	90334.47
2014	101242.89
2015	112355.34
2016	122546.77
2017	132527.66
2018	137432.44
2019	142356.21
2020	145327.25

From Table 4 in the text, it can be seen that "blockchain," "information asymmetry," "agricultural supply chain finance," "supply chain finance," and "small- and medium-sized enterprises" have high network homogeneity and good clustering effect. The lowest homogeneity is cluster 4 and

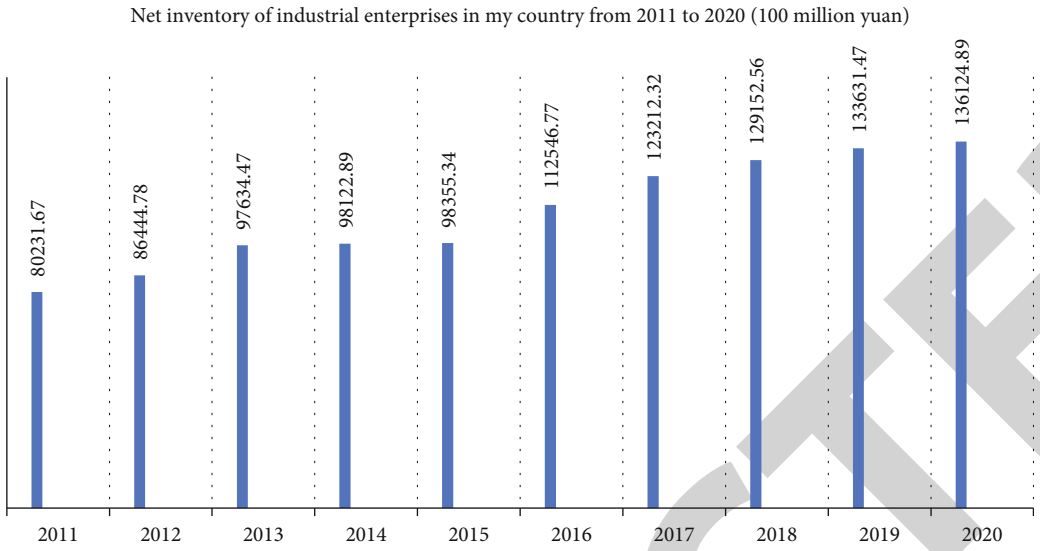

Figure 4: Inventory of my country's industrial enterprises from 2011 to 2020.

Table 2: Net receivables from industrial enterprises in my country from 2011 to 2020.

Inventory of my country's industrial enterprises from 2011 to 2020	
2011	80231.67
2012	86444.78
2013	97634.47
2014	98122.89
2015	98355.34
2016	112546.77
2017	123212.32
2018	129152.56
2019	133631.47
2020	136124.89

cluster 5, which are 0.921 and 0.949, respectively, which indicates that the whole cluster has a strong rationality.

It can be seen from Table 4 that the three largest clusters are cluster 0, cluster 1, and cluster 2, and the number of documents is 30, 28, and 25, respectively. Furthermore, 5 of the 12 clusters had an average score of clusters 1, i.e., the blockchain information asymmetry. Agricultural supply chain financing, supply chain financing, and SMEs have high network uniformity and the best clustering effect. The homogeneity of cluster 4 and cluster 5 is the lowest, which are 0.921 and 0.949, respectively, indicating that the cluster as a whole shows a strong rationality. In addition, the average release year of the 7 clusters including blockchain, blockchain technology, commercial banks, and small and microenterprises is 2019, which indicates that these clusters are hotspots of research trends in these fields and are closely connected and keep pace with the times.

4.3. Blockchain and P2P Financing Model. P2P is an innovative financial model based on the rapid development of Internet technology and the characteristics of economic development, focusing on the financial difficulties of small- and medium-sized enterprises. It provides small loans to applicants through a third-party platform. These include peer-to-peer or personal loans. Topics include third-party mediation platforms, SMEs, fund providers, and other service providers. The financial service platform only charges handling fees, does not interfere with the operation of the project, does not provide guarantees, and does not assume risks. In terms of P2P transactions, there has been a trend of first increase and then decrease in recent years. It peaked in 2017 and then declined year by year. By 2019, the transaction volume was 964.511 billion yuan, down 46.26% from the previous year in 2018. At the same time, the balance of industry loans has decreased; from the perspective of industry development, the balance of loans has declined year by year, mainly due to the transformation of some platforms, investor caution, and the so-called "three declines" in the observation. It is shown in Figure 5.

In terms of P2P services for small and microenterprises, statistics show that from 2014 to 2017, there is a positive correlation with the development of the industry. Small and microbusiness transactions also declined in 2018. It is shown in Figure 6.

Although P2P platforms provide a new way to draw money channels facing the enterprise by raising useless funds from society, the financing conditions are short and the cost is relatively high. The lending rate of P2P platforms is generally 10-20%, and the platform will also require a certain interest rate. The interest rate of commercial loans within one year is usually around 5%, and the higher financing cost increases the burden on the development of small- and medium-sized enterprises. At the same time, due to lack of funds and weak supervision, P2P platforms are mixed in nature, a large proportion of websites are outside financial supervision, and most of their activities are on the verge of breaking the law. In particular, the "thunderstorm" incident in recent years has profoundly reflected the flaws in the

Table 3: Some cooperative institutions and companies that have joined the alliance chain.

Organization type	Part of the list of institutions that have joined the alliance chain
Commercial Bank	Minsheng Bank, China CITIC Bank, China Everbright Bank, China Zheshang Bank, etc.
Joint venture	Tencent, Alibaba Cloud, Fun Chain Technology, Net Record Technology, Zhonglian Technology, etc.
Small loan company	Lujin Loan, You and Me Loan, Renren Loan, Huijinsuo, etc.
Asset management company	Great Wall Asset Management Company, China Railway Construction Asset Management Company, etc.

Table 4: Keyword clustering table.

Cluster number	Number of documents	Network homogeneity indicator	Average year	Cluster name
0	30	1	2019	Blockchain
1	28	0.961	2019	Blockchain technology
2	25	0.992	2018	Industrial chain
3	21	0.992	2018	Blockchain finance
4	20	0.921	2017	Financial innovation
5	17	0.949	2019	Commercial Bank
6	14	0.954	2019	Small and micro enterprises
7	12	1	2017	Information asymmetry
8	11	1	2019	Agricultural supply chain finance
9	11	1	2018	Supply chain finance
10	11	1	2018	SMEs
11	10	0.96	2019	Internet of things
12	6	0.987	2019	Trade acceptance draft

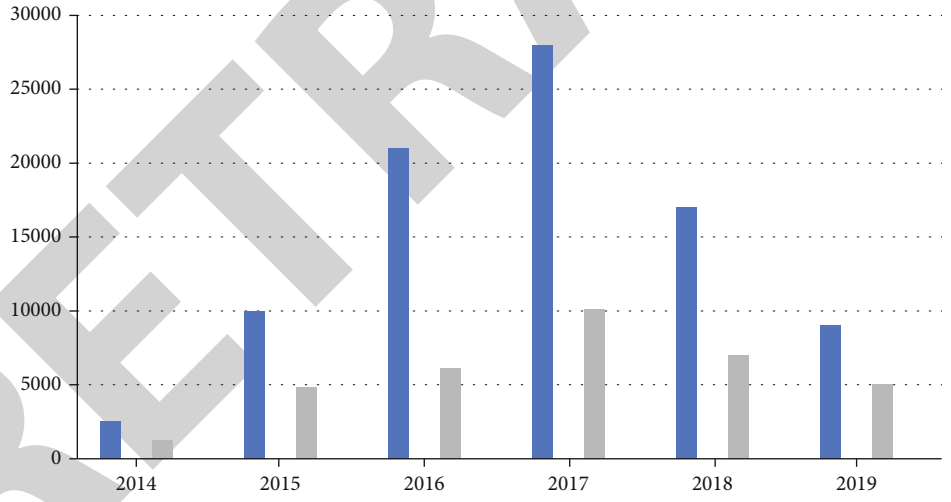

Figure 5: Transaction volume of China's P2P financial industry from 2014 to 2019.

development of the industry. The platform is a virtual or unreal target of illegal fundraising, resulting in financial fraud that does not protect the legitimate rights and interests of investors. P2P platforms have experienced a large number of failure events over the years, resulting in significant negative consequences, exposing the underlying flaws and inadequacies of the model, and are in the process of being phased out and disappearing. It is shown in Figure 7.

The rapid development of most things is largely due to improved infrastructure. From today's point of view, blockchain technology can be seen as a very important new infrastructure for P2P on the Internet and even the entire financial system, as well as a huge change in the highway transportation industry and the container in the shipping industry.

4.4. Supply Chain Financial Risk Assessment and Control. In a relatively closed supply chain network, through close cooperation, supply chain financing can solve capital problems at various stages, shorten the cash flow cycle, and reduce the operating cost of enterprises, but as a "double-edged sword," it can lengthen the supply chain. The operational efficiency

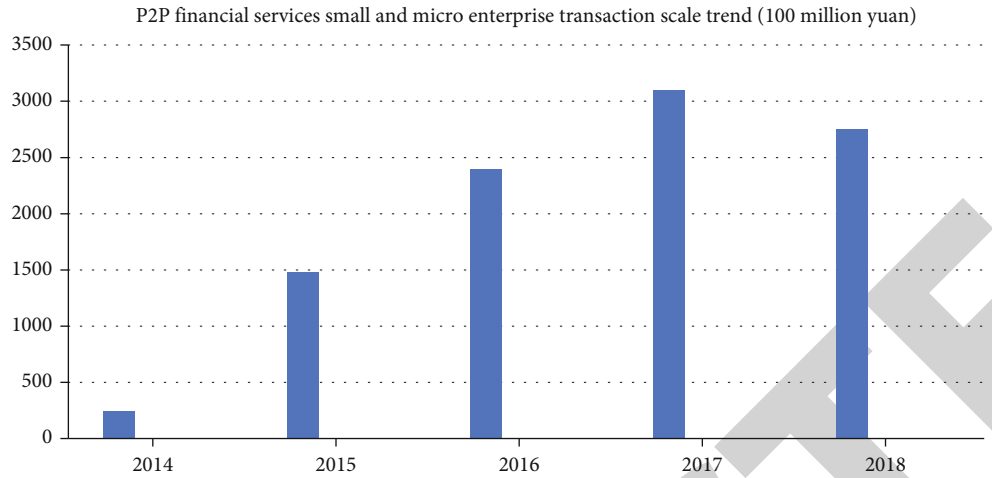

Figure 6: Trend of transaction scale of P2P financial services for small and microenterprises (100 million yuan).

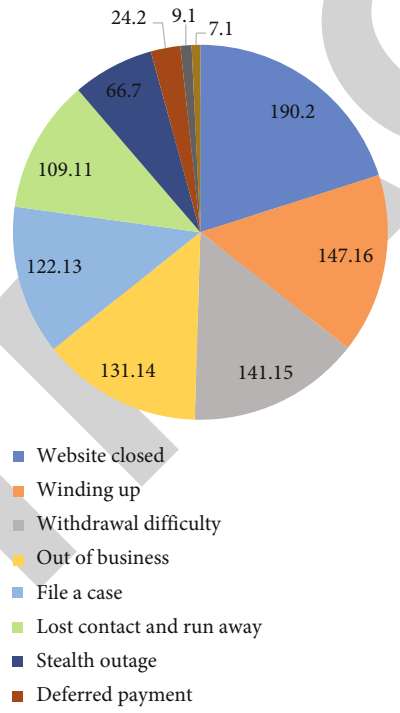

Figure 7: Distribution of P2P financial platform problem types.

of a company also introduces certain risk factors into activities. To assess financial cyber risk in the supply chain, we mainly study the internal risk of enterprises, and the results are shown in Figure 8.

As shown in Figure 8, we know that the probability of occurrence of supply chain relatedness risk is the lowest at 5%; the highest proportion of supply chain trade background risk is 23%, and other inherent risks have occurred, and these inherent risks should occur frequently. Carry out risk control and assessment, and summarize the data obtained from the assessment in a timely manner. We also manage and control according to the risk and summarize the following methods. We have investigated the use ratio and effectiveness of these methods. The data is shown in Figure 9.

As can be seen from the figure, we have summarized the 7 most commonly used methods for risk management and control. The minimum effective degree of strengthening internal control to prevent operational risks is only 0.57; clarifying the rights and obligations of all parties reduces legal risks and gradually builds a complete supply chain The financial risk assessment model and the establishment of a professional supply chain financing operation team are very close to the effectiveness of these three methods, all between 0.9. In terms of proportion of use, establishing a rapid market commodity information collection and feedback system is the most used method to prevent risks, and the least used method is to prudently select the supply chain group to be credited. For supply chain financial risk

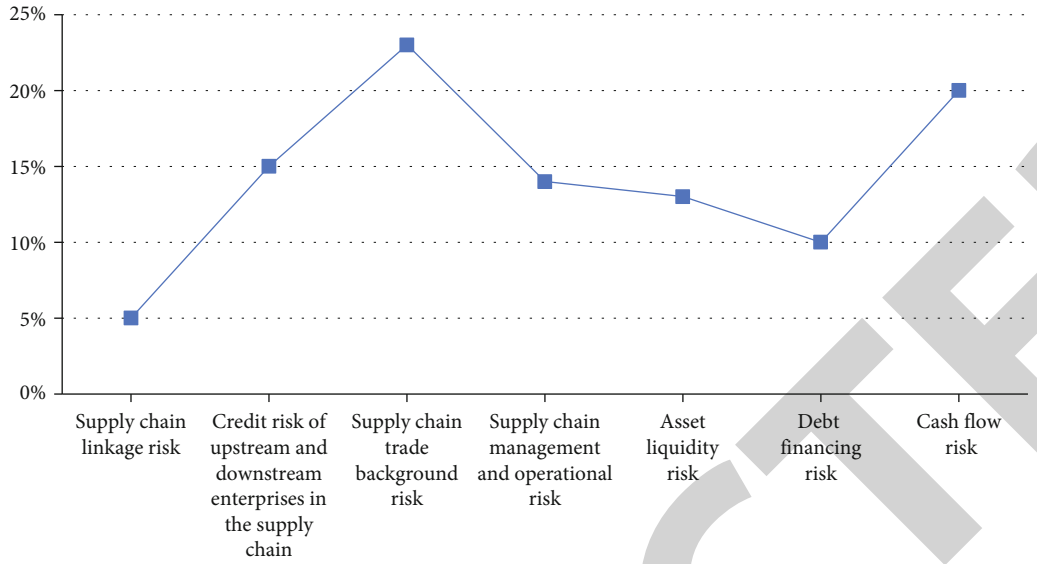

Figure 8: Proportion of inherent risks in supply chain finance.

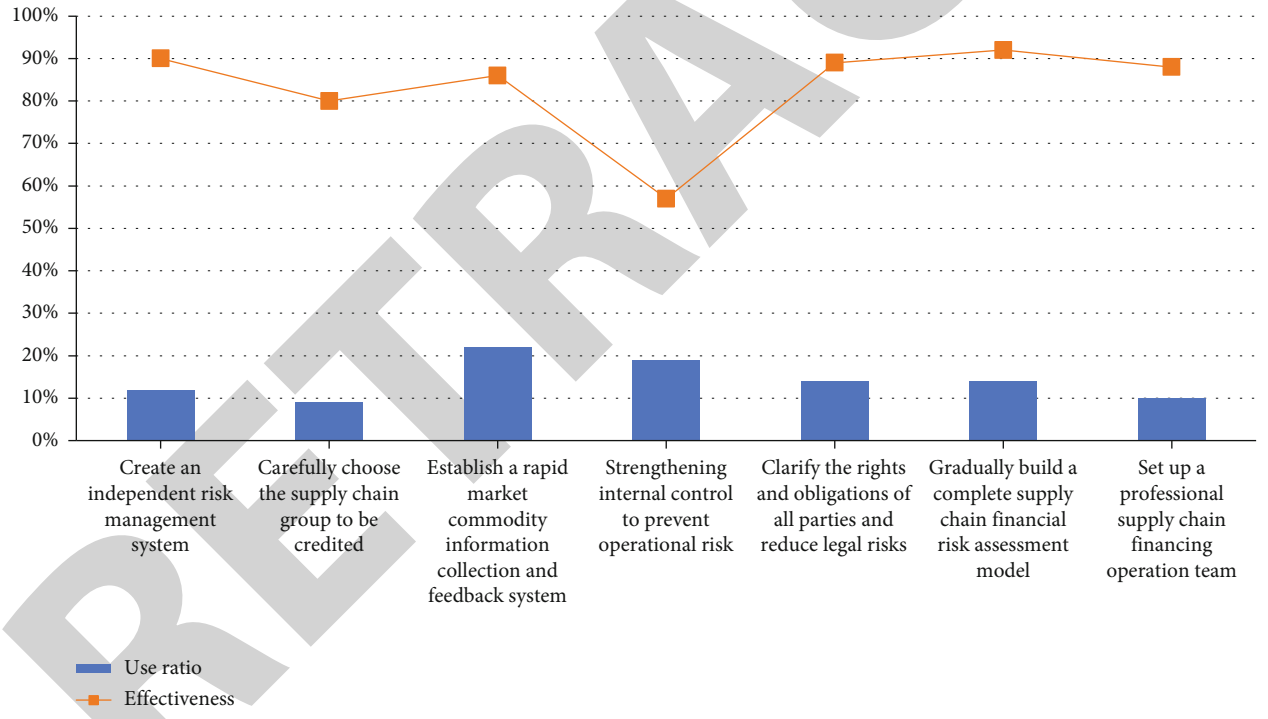

Figure 9: Comparison of the proportion of risk management and control methods used and the degree of effectiveness.

control, we must be rigorous and reduce the occurrence of risks and the harm caused by them. Risk management is particularly important.

5. Conclusion

This paper makes a detailed introduction and investigation of supply finance under the blockchain technology. Finance under the blockchain has better development prospects and is constantly being used by people in the development of the times, but security issues have become the top priority. We introduced the problems encountered by the blockchain and studied the algorithms corresponding to the blockchain. It is convenient for people to deal with the blockchain problem, and an industrial enterprise is taken as an example to study supply chain finance. Supply chain finance under blockchain technology has corresponding risks, and a comparative study has been made on the risks that may be encountered and the corresponding risk management and control.

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Retraction

Retracted: Edge Node Aware Adaptive Data Processing Method for Ubiquitous NB-IoT

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] F. Sun and Z. Diao, "Edge Node Aware Adaptive Data Processing Method for Ubiquitous NB-IoT," *Journal of Sensors*, vol. 2022, Article ID 9006152, 9 pages, 2022.

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Research Article

Edge Node Aware Adaptive Data Processing Method for Ubiquitous NB-IoT

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Nowadays, we have entered the golden age of economic development, and the Internet of Things (IoT) has also ushered in the opportunity of development, and the rapid development of IoT is also beneficial to drive the economy forward continuously. Therefore, the research on IoT is very meaningful and meets the contemporary development needs and greatly facilitates people's daily life through the interconnection of all things. In today's era of massive data, all kinds of data are complicated and messy, and if the large amount of data obtained is not properly classified and processed, the major problem will be that a pile of disordered and messy data is generated, and it is impossible to find the corresponding useful, engineering value, and regular data among them, and then, such data can only be discarded. Such a simple and brutal way of data processing is not only a waste of data resources but also may inadvertently throw away important, confidential, and private data information. If such data is carelessly discarded, the consequences will be incalculable, because such data information is likely to be used, processed, and disseminated by unscrupulous elements, which will eventually result in the following consequences: for individuals, it is equivalent to making their privacy public, which will seriously affect all aspects of life; for enterprises, if confidential data information is disseminated, then it will bring unpredictable losses to the enterprise. The adaptive data processing method for edge node sensing in ubiquitous NB-IoT can make the data generated from NB-IoT modules in ubiquitous IoT have practical engineering application value after processing, so the data source of this paper is the IoT data generated from NB-IoT communication modules in ubiquitous network (called NB-IoT dataset in this paper). The experimental results show that the accuracy of the adaptive data classification achieved by these two algorithms reaches about 75%, which provides some help to improve the efficiency of data utilization.

1. Introduction

As the economy continues to develop, the era of Internet of Everything has arrived, which can provide some help to change the human lifestyle [1]. What is the Internet of Things? First of all, the English translation of the Internet of Things is Internet of thing, which is abbreviated as IoT. "Internet of Things" literally means that an object or intelligence is connected to a network, i.e., the object or intelligence contributes information by connecting to the Internet and generates useful information based on it and does not require human involvement in the process, and this self-sufficient mechanism is called the Internet of Things [2].

IoT can be divided into several application markets from the cybersecurity level. The first is the service application, which refers to the application market that uses the results of data analysis to provide a specific service; the second is the analytical processing market, in which there are two forms: one is the consulting market, i.e., cybersecurity through a form similar to cyber consulting, and the second is the software market, which refers to the market which is the analysis of "things." The second is the software market, which refers to a data processing method that uses data analysis techniques to analyze the data collected by "things" [3]; the third is the platform, where "platform" refers to the IoT platform, such as Ali cloud and ONT-net. In the platform,

the activation, authentication, and billing of the "things" are realized in the platform service market of communication management. The fourth refers to the device, which is an important part of the IoT. In the IoT, the device refers to some modules that collect data; the fifth refers to the network, which is the basis and key of IoT communication. In this paper, the network under study is the ubiquitous network, and the IoT is the narrowband IoT, i.e., the edge sensing of NB-IoT.

At the beginning of the 21st century, a concept called "ubiquitous network" became known to people. The ubiquitous network enables people to connect to networks such as the Internet of Things (IoT) anytime and anywhere, which provides the hard conditions for data transmission and data sharing [4], where the ubiquitous network allows people to access the network anytime and anywhere.

Research on ubiquitous NB-IoT has always been a research hotspot, such as a research scholar proposed a design and implementation of shared parking space based on NB-IoT; in the research of the paper, the authors firstly described the current situation of parking space at home and abroad, followed by the design of two subsystems of parking space: one is the design of smart parking space lock, and the other is the design of cloud system of shared parking space. In the design of smart parking space lock, STM32 is used as the main controller, NB-IoT communication module is used for networking, and RTC clock module is used for clock control and timing; in the design of cloud system for shared parking space, the authors choose TLINK IoT platform as the server according to the status quo in order to provide the IP address of public network. In order to test whether the parking space only system can operate effectively, the authors used the WeChat applet approach to verify, and the final results show that the use of IoT can enable information interaction between people and things and can give full play to the role of IoT technology in some fields today such as intelligent transportation field, data security field, and adaptive data security processing [5].

Not only that, the research field based on ubiquitous IoT has been expanded from the original simple smart home and other common life scenarios to data processing, data analysis, and other data mining fields, such as some research scholars have presented their insights for data processing methods in power systems. In the paper, the authors firstly proposed that ubiquitous power IoT is important for electric power system, because using ubiquitous IoT can make the whole system realize more comprehensive information sharing and information opening, and at the same time, it is beneficial to connect in the ubiquitous power IoT system to realize more refined management of equipment. However, at the same time, there are some problems in the process of adaptive processing technology of ubiquitous power IoT edge-aware nodes, such as the response time of the edge node sensing adaptive data processing does not meet the requirements, and the security of the data processing process is not high, and there is a lack of certain standards in the process of data processing. To address these problems, the authors propose three methods to implement adaptive data processing techniques for edge-aware nodes in ubiquitous power systems [6].

In summary, in the era of rapid technological changes, the Internet of Everything has become a trend and can greatly facilitate people's lives in various fields of life, and the main research topic of this paper is the research of adaptive data processing methods for edge-aware nodes in ubiquitous NB-IoT. In Section 4, the paper will analyze the experimental data and results in detail and finally obtain comprehensive conclusions.

2. Research Background

2.1. Importance of Adaptive Processing Methods for Ubiquitous NB-IoT Edge Node Sensing

2.1.1. Edge Adaptive Data Processing Is More Advantageous Compared to Cloud Computing [7]. NB-IoT edge node sensing needs to design certain edge computing technology, and edge computing can push the communication and processing capabilities of gateways or smart devices directly into the devices, and then, these devices can use the capabilities of edge computing to determine which data can be stored locally and which data need to be sent to the cloud platform for further analysis and processing. And as technology grows, the capabilities of the IoT grow and connectivity improve, and the edge computing approach not only facilitates data storage and transmission but also enables certain adaptive data processing methods, while also improving the security protection of the data. Therefore, compared with pure cloud computing, the edge node aware adaptive data processing method for ubiquitous NB-IoT has more research significance and practicality.

2.1.2. Adaptive Data Processing at the Edge Can Solve the Security Problem to a Certain Extent [8]. Data always encounters various risks in transmission, and the data collected by sensors and the data at the edge may be affected by certain security threats. Therefore, security issues can be mitigated by adding some encryption algorithms to the edge adaptive data processing or by using gateways that work with the edge to store some sensitive data locally through the local network and by adding security systems and performing some data analysis in them in order to make the data more secure. In order to increase security, more secure communication technologies can be used, such as MQTT for uplink and downlink data communication.

2.1.3. Adaptive Data Processing at the Edge Can Reduce Bandwidth and Cost [9]. For companies and enterprises, large data centers and data security maintenance are required for data transmission and large amounts of data storage, and extensive network areas for interaction of massive data information require high cost support. Not only that, transferring massive amounts of data also requires high bandwidth support, and high bandwidth support leads to service degradation, which in turn can create data latency and data security issues, and these are additional costs incurred. However, for edge computing, it does not need additional bandwidth addition and only requires lower cost edge gateway to store and save data at the edge, so realizing adaptive data processing at the edge can reduce bandwidth

cost, which can save total cost and achieve the purpose of open source and cost saving.

2.2. Problems in the Adaptive Processing Method for Ubiquitous NB-IoT Edge Node Sensing

2.2.1. Long Response Time for Real-Time Control. In ubiquitous NB-IoT edge computing, there is the problem of long passive waiting time for data feedback at the edge side. The response time in the whole IoT system is the sum of the delay of each device receiving and sending data in the whole transmission link and the sum of the processing time of each level of device. Then, it will lead to real-time control reaction time which is too long; if it is automatic driving, robot surgery, and other requirements of high time precision control, then the reaction time process is a fatal disadvantage, so in practical applications, how to control the reaction time within a reasonable range is one of the more important breakthrough points. If the time control is unreasonable, it will lead to the response time of perceptual adaptive data processing for NB-IoT edge nodes that does not meet the requirements, which makes the adaptive data processing method unable to integrate the development characteristics of the big data era, thus limiting the application and innovation of ubiquitous networks in the perceptual adaptive data processing method for IoT edge nodes [10].

2.2.2. Security Needs to Be Improved. The IoT comes from a distributed test control system, the essence of which advocates decentralization and security, and nowadays, the research on IoT systems is based on cloud platforms or cloud servers. According to the barrel effect, whether in the NB-oriented IoT or power IoT, if there is a problem in one part of the system, such as power failure and network disconnection, then the reaction control is failure, which will lead to the whole IoT system or platform can not work, and then, security will also be affected to a certain extent, and serious may lead to the risk of data leakage. Similarly, in terms of data privacy and confidentiality, if some more sensitive and private data is stored directly in the IoT, then the data is extremely easy to be intercepted, controlled, and utilized by the unfaithful elements, thus causing the risk of data security [11].

2.2.3. Proliferation of Edge Data. In recent years, as artificial intelligence has been vigorously developed, the concept about IoT technology has been gradually known and become the measurement and control end of the industrial Internet. According to the prediction of relevant data, compared to cloud computing, in the next few years, the edge-side data of enterprises outside the cloud or in traditional data centers will be higher than the current data storage volume by 75% [12]. This shows that the amount of data at the edge of IoT is proliferating, which in turn also leads to the situation that the traditional methods about massive data processing are not applicable to the current IoT system with proliferating edge data, so it is more important and practical to study an adaptive data processing method about physical network edge node sensing that is suitable for today's data status [13].

2.2.4. Not Good Identification of Useful Information. As can be seen from point 3, the development of IoT technology has been greatly promoted by the development of artificial intelligence and the advanced network in recent years. However, in the process of IoT development, the amount of data about the edge end is also proliferating, and the impact of such exponential data proliferation may lead to the problem that today's data processing methods are not applicable to the current situation, and not only that, it will also lead to the increase of invalid transmission and the situation that IoT systems cannot identify useful information well. Compared with cloud computing, the raw data collected by IoT edge-side sensing, such as haze data collection of atmospheric environment, temperature collection, carbon dioxide content measurement, and other data, are many invalid data. According to a survey, the invalid data and the data that can be discarded after computing occupy 50%-70% of the total data in the IoT system [14], this part of useless data information will also be transmitted in the network because it is not discarded, but this invalid transmission method that cannot identify useful information well and discard useless information will undoubtedly increase the load pressure on the network [15].

3. Materials and Methods

3.1. Overview of the Internet of Things. From Section 1, it is clear that the Internet of Things (IoT) refers to the "Internet of Things connected to people," which specifically refers to the interaction of information through various sensor devices and the connection of all objects used to the Internet for information interaction, uplink and downlink communication, and information and data processing and analysis according to an agreed protocol, such as the MQTT protocol. It is a network that identifies and measures certain factors in life, such as temperature, humidity, and carbon dioxide content, and has the ability to track, manage, and monitor them [16]. The three-layer structure of the Internet of Things is shown in Figure 1.

From Figure 1, it can be seen that the three-layer structure of IoT has application layer, network layer, and sensing layer. Among them, the application layer can also be called the transport layer, and in this layer, the contents included are the application interface layer and the technical support layer. This process needs to be combined with the needs of the industry for the purpose of service presentation and service development through its connection to the web layer. In the network layer, the main refers to the use of the Internet to complete the communication link of uplink and downlink data communication, including the transport layer and communication layer. In the transmission layer, the main thing is to use the Internet, sensor networks and mobile communication networks, or other convergence technologies, to transmit the data information sensed by sensors and other devices in an unobstructed, highly reliable, and secure data link. In the communication layer, the information collected in the sensing layer is combined and aggregated through various network technologies, and the massive amount of information obtained is integrated together for subsequent processing. For the perception layer,

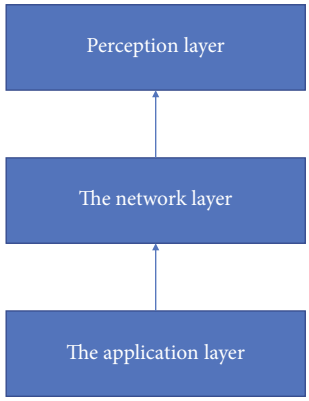

Figure 1: Block diagram of the three-layer structure of the Internet of Things.

at the hardware level, various sensors are used to collect data from the real world, and through certain means, generally at the software level, the collected data are processed and analyzed in real time and transformed into data or information that can be processed in the virtual world. Technology (RFID technology), etc.

From the above, it can be seen that IoT can be roughly divided into three layers, so what are the characteristics of that layer? What are the advantages of using IoT to implement adaptive data processing methods?

First of all, IoT has the characteristic of comprehensive sensing. In this feature, it is expressed that IoT is a collection and wide application of various different sensing technologies. As can be seen from the above, there are a large number and many types of sensor devices deployed in the perception layer of IoT, and each sensor is a different source of information; collecting the same type of data information or different types of data information, not only that, the format of the data information collected by different sensors may also be different, and the characteristics of the sensor are that the data information from the sensor device has real time. Therefore, IoT has the ability of comprehensive perception for the real world, which also provides certain advantages in adaptive data processing [17].

The second feature is the reliable delivery. IoT can be said to be a kind of ubiquitous network of the Internet by nature. The ubiquitous network in this context is a unified level with "ubiquitous" in this paper. The data information collected by the above-mentioned sensors is interacted and transmitted through various wired and wireless networks, which are then integrated with the Internet, and the data arriving at the network layer will be transmitted by the Internet in a timely and accurate manner [18]. But to achieve safe, reliable, and accurate data transmission in IoT is a huge project of heterogeneous various network protocols, which is not the main research content of this paper, so this paper does not consider this aspect and set the security of data transmission within a reasonable range.

The third feature is that IoT has the ability of intelligent processing [19]. In the IoT, not only does it provide a communication channel between sensors but it also has the ability of intelligent processing, which enables intelligent control of objects. In IoT, the main way to achieve this function is to use various intelligent technologies, such as pattern recognition, deep learning, and other technologies, to integrate into the algorithmic programming of IoT. Not only that, IoT can also select, process, and process useful information from the vast amount of information collected by sensors to suit the needs of different users [20].

3.2. Data Processing for Ubiquitous NB-IoT. In the physical layer of IoT, NB-IoT is called narrowband cellular IoT, so what is the difference between narrowband IoT and the IoT that is often referred to? First of all, this narrowband requirement is reflected in 180 kHz; the band is equivalent to the width of the protected broadband of 4 G; that is to say, NB-IoT network is based on 4 G network and evolved from 4 G network. One of the general architectures regarding NB-IoT data transmission and data processing is shown in Figure 2.

In Figure 2, NB-IoT goes through a total of five endpoints and six processes from the NB-IoT terminal to the data endpoint. It starts with NB-IoT sending data to the base station, but the preparation work before the start should realize the air port connection from the NB-IoT terminal to the base station, and then, the data is sent to the base station through the NB-IoT terminal. The base station, also known as eNodeB, is to realize the connection with the IoT core mainly through the S1-lite interface, in which the connection between the base station and the IoT core network is realized, and the nonaccess layer is stored in the wireless communication protocol stack, and the stack that is generally stored is UMTS, and it is used as the functional layer between the NB-IoT and the sensing device. The NB core network is equivalent to a data transfer station, not only assuming the function of sending the obtained data to the IoT platform for analysis and processing but also having the function of data interaction with the nonaccess layer of the data terminal. The IoT platform is equivalent to the aggregation layer, in which all the data are collected and integrated according to the different types of data, and the function of data forwarding is realized, in which the organized data information is forwarded to different data terminals for processing; finally, the data transmission and data processing in the whole NB-IoT core architecture are completed, and the data arriving at the data will be processed by the terminal according to different needs.

3.3. Architecture for Ubiquitous NB-IoT. Ubiquitous NB-IoT is a kind of integration of a variety of information technology and communication technology use, among which information technology has artificial intelligence, mobile Internet, etc. It is important for the research of adaptive data processing methods. The research of adaptive data processing methods for edge sensing nodes can deepen and promote the research based on ubiquitous NB-IoT oriented and can improve the stability and normal operation when using NB-IoT communication modules for data transmission and analysis and improve the ability of NB-IoT to process data by incorporating Bloom filtering algorithms or

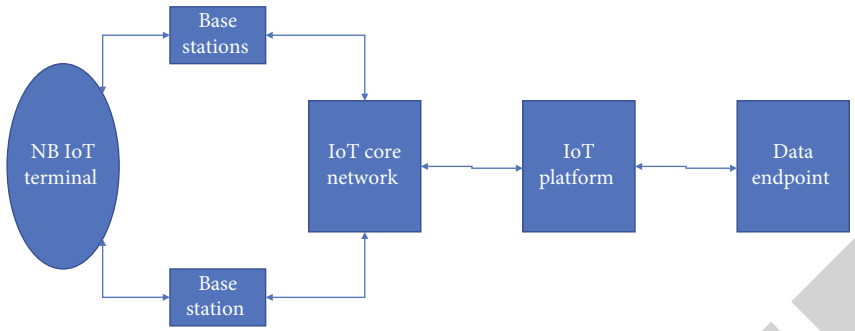

Figure 2: The overall architecture of NB-IoT data transmission and processing.

neural network algorithms on the original basis. The IoT under ubiquitous network is shown in Figure 3.

From Figure 3, it can be seen that the ubiquitous network exists in the whole IoT system and provides the channel for information interaction for the whole NB-IoT. If the upstream and downstream communication of data is realized under the ubiquitous Internet of Things, then the Internet on the left can be taken as the sensor device side and the Internet on the right as the cloud platform side as shown in Figure 3. The direction of uplink communication is to upload the collected data to the cloud after processing by certain means such as MQTT protocol; the direction of downlink communication is to summarize and process the data obtained from the uplink communication by the cloud platform and to respond the processing results to the device sensors. The whole uplink and downlink communication is carried out under the ubiquitous network and through the Internet-based transmission of the Internet of Things system.

4. Results and Discussion

According to the description of security issues in the IoT in Section 2, it is known that if the data is directly stored in the IoT system or platform directly, then it is easier to have security problems, so this paper advocates to store some hidden and high confidentiality demand data in the data security protection procedure based on the network edge, because the protection of data security by storing the data in the edge IoT nodes is far better than centralizing data directly to data storage services and also improves certain security in transmission, but in practice, it is not recommended to transmit less data with high privacy and confidentiality needs of this kind. In summary, excluding the security issue, this paper then proceeds to complete the study of adaptive data processing methods for edge node sensing of the entire ubiquitous NB-IoT by comparing and analyzing different algorithms in terms of their efficiency and performance.

In this paper, the data collected in the ubiquitous NB-IoT through hardware conditions are converted in a certain format and form to form the NB-IoT dataset, but in the NB-IoT dataset, there are both valuable IoT data and meaningful non-IoT data. In this section, we implement the adaptive classification process for this dataset.

4.1. Bloom Filtering Algorithm. The Bloom filtering algorithm is the procedure used in the Bloom filter and consists of a random data structure, where the data structure is particularly efficient in space. Bloom filter is a combination of the underlying array and hash function together, the principle of Bloom filter is relatively simple, and we filter the data by using Bloom filter and by formulating a reasonable dataset, Bloom filtering accomplishes the information processing by determining whether a certain data is in the set or not. If the value has already been marked, it is recorded as 1; otherwise, it is recorded as 0. The formula for calculating the error rate of the Bloom filter and the formula for calculating the concept of being set to 1 are shown in

$$\left(1 - e\left(\frac{-nk}{\text{size}}\right)\right)k, \tag{1}$$

$$\left(1 - \frac{1}{m}\right)^{k}. \tag{2}$$

For the above formula, where size is the size of the bit set, n is the number of target data, k is the number of hash functions used, and m is the size of an array of bits in the bit list. The flow of the determination of the value using the Bloom filter is shown in Figure 4.

In order to verify the efficacy of this paper for the method of adaptive output data processing for edge node sensing of ubiquitous NB-IoT, this paper designs the relevant NB-IoT module and collects the data and then achieves the classification performance of NB-IoT data by Bloom filter, where the experimental results are shown in Figure 5.

From Figure 5, it can be seen that by using Bloom filter to classify the NB-IoT dataset, the final classification result obtained is 232 MB for IoT data and 68 MB for non-IoT data; the total data is 310 MB, of which the data loss is 10 M.

In the obtained NB dataset, besides, IoT data, there are also non-IoT data and other data such as BER and processing data. After using Bloom filter to classify the IoT dataset, then the BER of the obtained data classification is shown in Figure 6.

Observing Figure 6, it can be seen that using Bloom filter for BER test on NB-IoT dataset, it is found that the BER of Bloom filter for IoT data will be higher, higher than in about

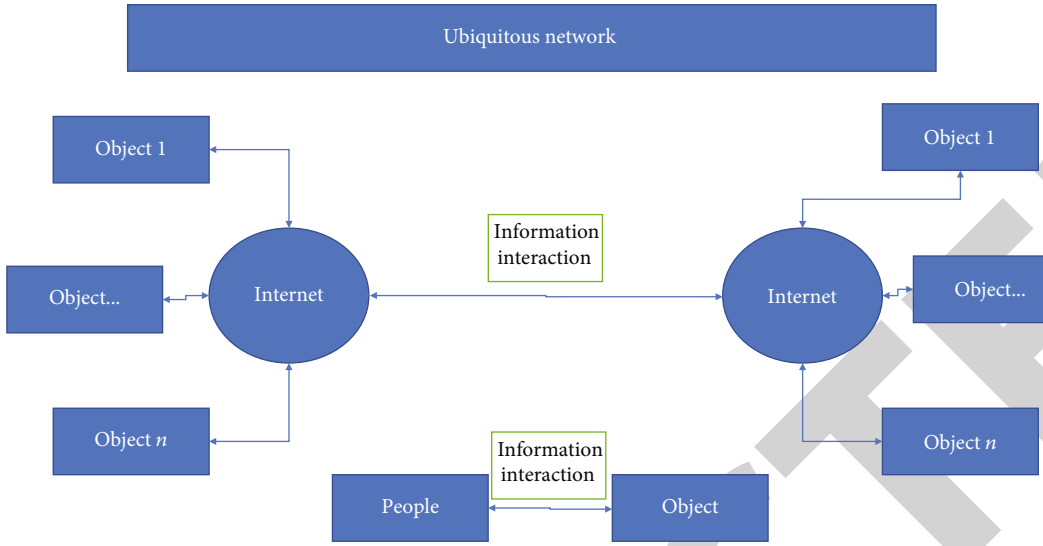

Figure 3: IoT under ubiquitous network.

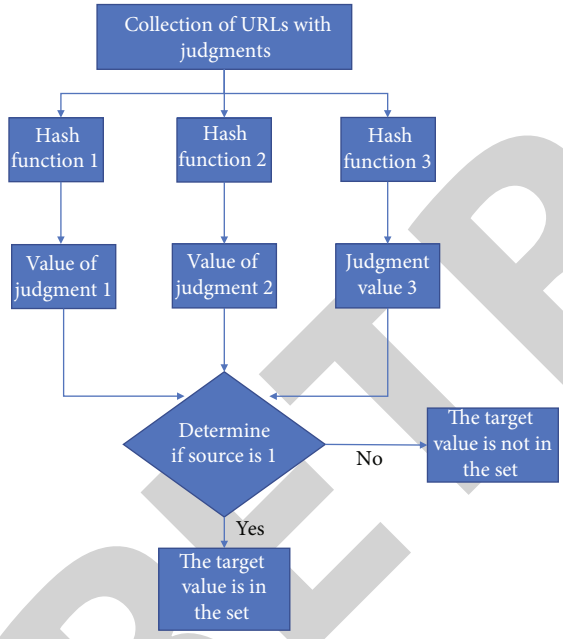

Figure 4: The flow of value determination by Bloom filter.

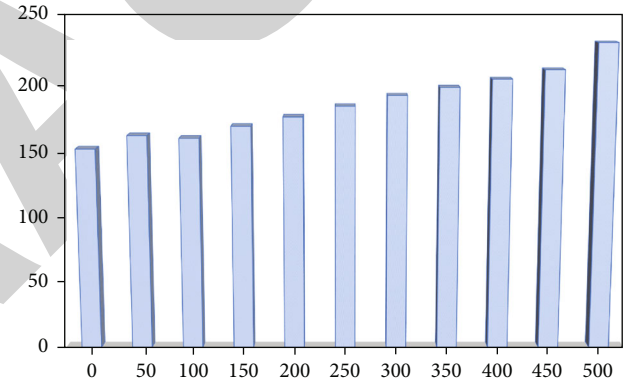

Figure 5: The results of Bloom filter for IoT data in NB-IoT dataset.

0.1. And as the number of tests increases, for the NB-IoT dataset, data for both IoT and non-IoT or other data increases with the number of tests, but the overall increase in the interval is not large, greater than between [0, 0.13]. In the dataset in this article, the number of tests has reached 10 times, and the situation of each time is recorded accordingly. In the end, the curve shown in the figure is formed. There is a turning point between 6 times and the 8th time. It can be speculated that in the 10 tests of this round, there is a test value for the test of the Bloom filter for the NB-IoT dataset of this article. The test value at the beginning is not necessarily the best, and the minimum error rate may occur in the subsequent test value.

4.2. Adaptive Gradient Method (Adagrad). Mathematically, neural networks are an operational model. It is an imitation behavior for bionics. It is imitated with human thinking habits and thinking methods and has the ability to calculate and express people, which is equivalent to a smart body. After continuous development and growth of neural networks, there are many neural network algorithms, which have also emerged many algorithms for adaptive optimization of data processing, such as RMSprop methods, Addelta methods, and adaptive gradient algorithms. Among them, the adaptive gradient method is derived from the gradient drop algorithm, so the training speed of the adaptive gradient decrease method will be faster. However, because only one sample is trained in each iteration process, the gradient method has higher accuracy for the original gradient decline method, and the convergence speed will also increase.

To understand the adaptive gradient algorithm, you need to start with the fundamental gradient decrease algorithm. The gradient drop algorithm is proposed based on the optimization problem, mainly to solve the problem of

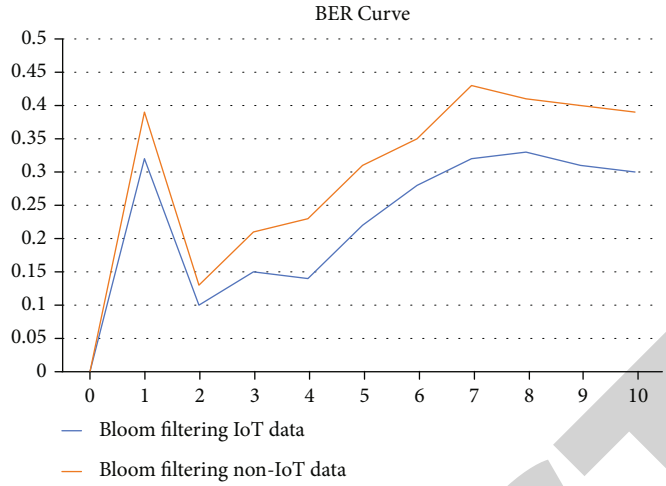

Figure 6: Bloom filter's IoT data and non-IoT data error rate curve.

the maximum and minimum value of the overall situation, and in the actual application of machine learning, the most optimized problem is generally described as a minor value problem of a certain function. The gradient drop algorithm is one of the methods to solve this problem in machine learning.

The gradient drop algorithm is mainly obtained according to the number and gradient in mathematics, and the gradient is the guidance of the function and determines the direction of the entire model. In the entire neural network model, if a certain algorithm is used, it is necessary to pay attention to the setting of the initial value, the setting of the learning rate, and the design of the network structure of the entire neural network model. This paper investigates adaptive data processing methods for IoT edge-aware nodes under ubiquitous networks. Therefore, for data implementation adaptive processing, this article uses the adaptive gradient algorithm to complete the error data contained in the NB-IoT dataset to filter and screen it.

$$h + \frac{\partial l}{\partial w} \odot \frac{\partial l}{\partial w}, \tag{3}$$

$$w - \eta \frac{1}{\sqrt{h}} \frac{\partial l}{\partial w}. \tag{4}$$

It can be seen from formulas ((3)) and ((4)) that h is an intermediate variable of the weight renewal formula, and w is the weight η to be updated, which represents the learning rate of adaptive gradient algorithm. For formula (3), because the adaptive gradient algorithm retains all the previous gradient data, the existence of this formula can ensure the square harmony of all the previous gradient values, which $\odot$ indicates the dots of the matrix. After the h value is found, the value of the learning rate is adjusted by the countdown of the root η number 2 in formula (4). In other words, the use of these two formulas to the algorithm can be modified by updating and learning rates, which can make the neural network model decay in accordance with the elements of the agreed parameters. To adopt a small learning rate for large-changing parameters, a larger learning rate for more stable parameters is the theoretical result of the adaptive gradient algorithm.

In summary, by using the adaptive gradient algorithm, the NB-IoT dataset of the edge nodes of the Internet of Things is used to process the adaptive data processing. The comparison curve of the error rate of the adaptive gradient algorithm obtains the adaptive gradient algorithm as shown in Figure 7.

In Figure 7, the adaptive data classification is performed by the NB-IoT dataset filtered by the NB-IoT data and adaptive gradient algorithm filtering under Bloom. The ingening rate of the IoT data filtered by the blue curve part of the blue curve part, the orange curve part represents the misintering rate of the IoT data filtered by the adaptive gradient algorithm in the neural network model. The code rate of both the IoT data filtered under Bloom filtering and the IoT data filtered by the neural network model eventually stabilized around 0.3, but the number of misinterpretations for both at the same location was the time from the 0th to the 2nd test. In the second time, there was a particularly large turning point. The reason for the problem that caused such a large turning point should be caused by improper selection of the initial value. For adaptive gradient algorithms, a large part of the learning rate is not appropriate, but it is finally adjusted to the optimal value through formula (3) and formula (4). Therefore, after the second time, the misunderstanding rate suddenly decreased directly. After continuous adjustment of the related parameters of the Bloom filtering algorithm and adaptive gradient algorithm, the error rate of the two algorithms in the end is stable at about 0.3. But in terms of stability, the stability of the Bloom filtering algorithm or the adaptive gradient algorithm is not high. The accuracy of the adaptive gradient algorithm based on the edge perception nodes under the pan-IoT is shown in Figure 8.

The ACC curve of IoT data classification based on the adaptive gradient algorithm under the neural network model is shown in Figure 8. ACC represents the accuracy rate. According to the curve in the figure, the adaptive

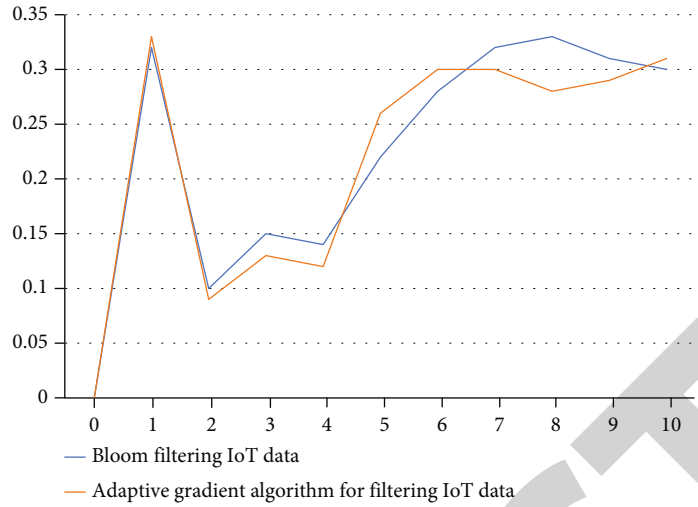

Figure 7: The comparison of the two different filtering methods under the same NB-IoT dataset.

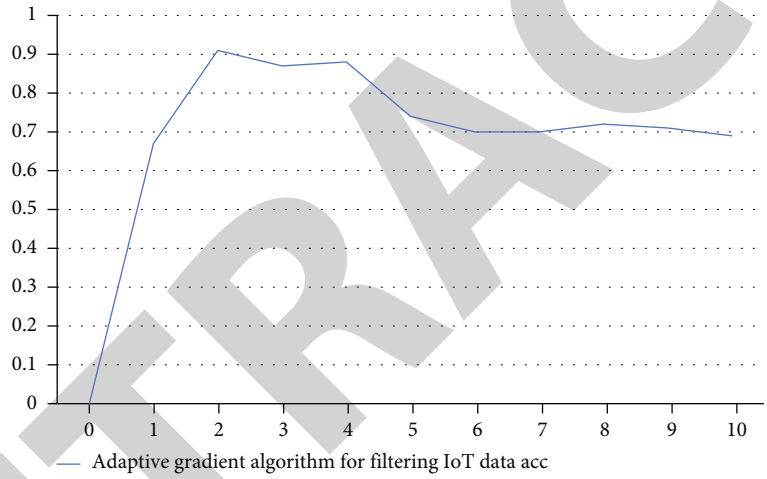

Figure 8: ACC curve of IoT data filtered by adaptive gradient algorithm.

classification results of NB-IoT data under the adaptive gradient algorithm can reach a stable level after the 7th to 10th times.

5. Conclusion

In this paper, firstly through the analysis of relevant literature and finally through the development of the Internet of Things and economy are discussed, the Internet of Things and economic development are complementary to each other, so the data processing method based on the ubiquitous NB Internet of Things in this paper has a certain practical significance. In the research background of Section 2, two aspects are mainly discussed. First, the importance of adaptive data processing method oriented to ubiquitous NB Internet of Things edge node perception is discussed. Second, the problems existing in mass data processing method in Internet of Things are summarized. Finally, an adaptive data processing method for edge node perception of ubiquitous NB Internet of Things is necessary. In Section 3, firstly, a theoretical overview of the Internet of Things is given. Secondly, the role and significance of ubiquitous network in NB Internet of Things are emphasized, and the structure of ubiquitous NB Internet of Things is analyzed. The results and discussion in Section 4 are the core of this paper. In this chapter, two different algorithms are used to classify data in ubiquitous NB Internet of Things. The final experimental results show that the Bloom algorithm and the adaptive gradient algorithm have similar stability, and the accuracy is about 75%.

Data Availability

The dataset is available upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Retraction

Retracted: Risk Mechanism and Architecture of Investment and Financing Based on DEA-Malmquist Index

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] J. Chu, "Risk Mechanism and Architecture of Investment and Financing Based on DEA-Malmquist Index," *Journal of Sensors*, vol. 2022, Article ID 3613624, 10 pages, 2022.

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Research Article

Risk Mechanism and Architecture of Investment and Financing Based on DEA-Malmquist Index

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After the outbreak of the epidemic, the external environment has changed, affecting social and economic development. In the unfavorable economic and social environment, the behavior of many businesses and consumers has also changed. Therefore, companies do not have enough income and expenditure, which leads to the breakage of their capital chain or even bankruptcy. As a result, proper financing has been critical for many businesses in the near term. Today, listed companies are mainly financed from internal financing, equity, and debt. Generally speaking, most companies prefer debt financing because equity financing costs can be deducted before taxes and investment costs are lower than equity financing. Enterprises face certain risks when choosing debt financing; in addition, they also face the risk of future repayment. This paper adopts the research method of DEA-Malmquist index for analysis, which can effectively help enterprises avoid or reduce the risk of debt financing and is worthy of in-depth research and exploration by entrepreneurs and scholars.

1. Introduction

With the development of social economy, China has entered a new era of economic globalization. The age of globalization brings not only opportunities but also challenges. During the outbreak, ordinary people actively responded to national politics by working and studying from home.

Several listed companies have experienced business rotation difficulties and financing chain disruptions due to the COVID-19 outbreak. Many companies or enterprises produce products to fewer consumers, difficult to sell, partial shrinkage of production, and income decline. There are many financing channels for listed companies, but it is not easy for enterprises to effectively play the role of financing leverage and smoothly avoid financing risks. In this outbreak, most enterprise operating performance is very poor, whether the main basis and the company's operating efficiency; in this case, the money will be more timely delivered and will face the challenge, for the survival and development of society as a preemptive strike; the companies relative to the external environment change of the capital chain rupture problem early warning measures, such as the use of debt financing risk, prevent management by borrowing. The existence of financing risk, so as to take measures to reduce financing risk, can help enterprises overcome difficulties. Therefore, a stable financing chain is the source of life for enterprises in the context of a long-term fight against the epidemic. Enterprises can establish risks to prevent risks, improve financing efficiency, and reduce or avoid financing risks.

Technological innovation of enterprises is a business process from initial to complex. Technology transfer to the economic field requires at least two stages of RD achievement transformation and scientific and technological innovation. However, with the rapid expansion of the manufacturing industry, too much emphasis is placed on scientific and technological innovation, and the number of scientific research papers and patents is despised, and the utilization of scientific and technological research achievements is therefore not transformed into the final economic value. For the manufacturing industry, the fundamental purpose of scientific and technological innovation is to obtain more economic value, so as to realize the transformation and improvement of the manufacturing industry. Therefore, under the background of China's vigorous pursuit of scientific and technological innovation strategy, the innovation efficiency of high-end equipment manufacturing

enterprises is rationally evaluated to find out the root causes of innovation, improve the efficiency of technological innovation, and realize the effective allocation of innovation resources of high-end equipment enterprises.

This paper analyzes the innovation process from the perspective of value chain and tries to build a theoretical model of innovation value chain of high-end equipment manufacturing enterprises, so as to broaden the perspective of innovation efficiency research. From the perspective of value chain, the technological innovation activities of enterprises are decomposed into value chain. On this basis, the innovation efficiency of high-end equipment enterprises is studied from the perspective of mechanism and empirical analysis, and the research ideas of modeling are provided.

In recent years, China's market economy is in the development boom stage; enterprises want to keep up with the pace of the times, with the times, should learn to seize the fleeting business opportunities, by this opportunity to let their own enterprises grow. If an enterprise wants to seize this business opportunity as far as possible, it should first of all have capital as reserve power to support the decision-making of the enterprise. When it comes to capital, it is inseparable from the financing of the enterprise to relevant financial institutions or credit enterprises.

Enterprises have many options for financing, such as debt financing, equity financing, internal financing, and other three different financing.

Solution. For enterprises, dividends of equity financing are paid after tax and cannot be deducted before tax. Compared with debt financing, the cost of capital is higher, and the risk is greater. In addition, the biggest disadvantage is easy to disperse the control rights of shareholders. That is not what most shareholders want, so it is not the best choice. For the company, although internal financing is the best way of financing, there are still many factors that are not feasible. The dividends given to shareholders are reduced because in internal financing, companies can only choose to raise small amounts of money. If the dividends issued are too low, this will have a negative impact on the future.

For a normal operation of the company, the most important thing is to maintain the stability of the capital chain. We are keeping the financial chain stable.

In the process of setting, financing is indispensable. When it comes to financing, interest rate changes should be considered. Interest rate changes according to changes in the macroenvironment. Therefore, for companies, no matter financing or investment, these schemes are linked to the interest rate. Since the change of interest rate is uncontrollable, both investment and financing are subject to risks, but the risks are of different degrees. For the company, they are racking their brains to discuss the optimal plan, which can help the company to obtain the maximum benefits and at the same time bear the minimum risk of investment projects or financing plans.

In addition, innovation is the necessary guarantee of national development and prosperity, is the soul of the survival of the country, and is the inexhaustible power of enterprise prosperity. Among them, technological innovation is the product of economic market and is the product of all activities of research, development, production, and sales of new technologies.

In terms of research methods, this paper chooses the network model to measure the overall and phased innovation efficiency of high-end equipment enterprises, which solves the problem that traditional DEA model cannot measure the overall innovation efficiency of enterprises from the perspective of innovation value chain. At the same time, the global frontier Malmquist index is used to analyze the dynamic efficiency of high-end equipment enterprises. Finally, Tobit model is used to combine the two-stage innovation efficiency with panel data to find the key influencing factors of high-end equipment enterprises, which makes up for the research method of innovation efficiency in China.

The technical roadmap for this article is shown in Figure 1.

2. Research Background

Foreign scholars on the financing risk of a series of analysis and research. Wei et al. [1] believe that financial institutions raise the threshold of SME loans mainly because of their limited number of capital applications, resulting in increased information and transaction costs and reduced income. L'ubomír et al. [2] believe that its financing performance is at a medium and low level. In particular, its financial indicators are relatively poor, and nonfinancial indicators also have potential risks. Nikolaos et al. [3] discussed common financing methods and other potential risks of SMEs and adopted quantitative analysis to find out the causes and improve risk management. At the same time, research shows that legal constraints and national macroregulatory policies have the greatest impact on financing risks. There are also scholars working on issues related to the financing of micro and small scientific enterprises. Kyoungwon et al. [4] believe that financing difficulties of Chinese SMEs are mainly related to high financing costs and high questioning risks. They were established at the beginning of the year. Jamasmie [5] believes that small and micro enterprises lack effective supervision and management. Perfect management system can effectively reduce financing risk. Hiyate [6] believes that the main reason for the industrial development difficulties of micro-, small-, and medium-sized enterprises in China is the difficulty and high cost of foreign financing.

Hongyi [7] believes that in the context of big data, new financing methods are characterized by low cost and high efficiency, providing new impetus for SME financing. Mun [8] proposed that small and micro enterprises can rely on intellectual property rights to obtain financial support from financial institutions and enhance their market competitiveness by relying on technological strength. Li [9] believes that the intellectual property rights of micro-, small-, and medium-sized enterprises can provide financial support for enterprises, but there are also risks. Jieyu and Deqiang [10] analyzed the effectiveness of investment and financing partnerships of micro-, small-, and medium-sized technology enterprises, as well as the impact of spatial clusters and investment and financing partnerships on collaborative innovation. Xia [11] believes that small and micro enterprises need to make early assessment according to the actual

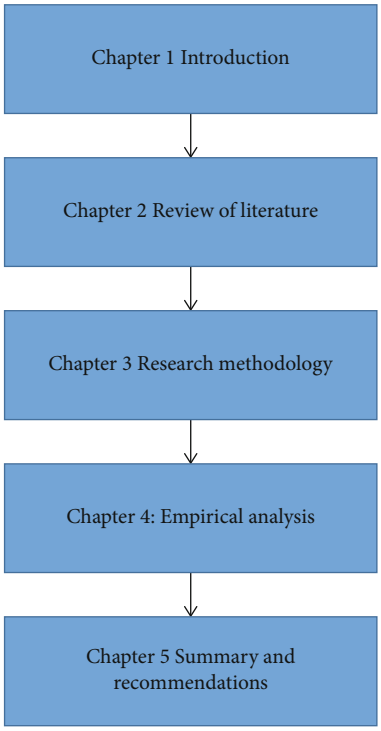

Figure 1: Technology roadmap.

situation in the operation process. Li [12] emphasizes that cluster development and cluster financing are effective solutions, and their financing risks can be timely transmitted and transferred through their supply chains and value chains. Li and Yang [13] believe that small- and medium-sized science and technology enterprises should establish a risk assessment system to comprehensively assess risks and take effective preventive measures. Antti et al. [14] emphasize that small and micro enterprises need to fully understand the legal environment and political system to promote the sustainable development of small and micro technology enterprises on the basis of dividends. The results of the research on capitalization risks of micro and small technology enterprises are striking. However, there are few researches on financing risks of micro-, small-, and medium-sized technology enterprises from the perspective of innovation. According to the company's capital operation, choose the right time to make financing decisions. Prudent investment, improve and optimize the credit market environment management, effectively solve the opaque accounting and internal management chaos, reduce the restrictions of credit financing, and strengthen the financial management ability and risk awareness of managers. Qihe et al. used analytic hierarchy process (AHP) to evaluate the financial risks of Dahua. Subsequently, the continuous exploration of Dahua produced control suggestions from risk avoidance, risk transfer, to risk holding [15]. According to the research of Batóg B. and Batóg J., the establishment of a more targeted financial risk early warning system requires the company to select financial indicators with more corporate characteristics and judge the impact of each decision on the risk. In addition, comprehensive supervision is required during the production and operation stages [16]. Nayyar took SAN Sihua and Hisense as research objects and conducted more studies by using the early warning system.

In order to accurately assess the company's financial risk, it is necessary to further improve the early-warning indicator system model and make necessary adjustments and improve the theoretical basis of the traditional method of efficiency coefficient, while considering nonfinancial indicators as one of the financial risk factors. As for the research on financing risk control, Yang et al. believe that enterprises are at different stages of development and need to adopt appropriate financing strategies. The capital structure of a company cannot remain unchanged forever but is constantly optimized according to the development status of the company.

Mohamad et al. proposed a variety of debt financing risk control methods, such as reasonable planning of financing plans, selection of diversified financing methods, and optimization of capital structure. Du Juan (2013) pointed out in her financial risk survey that financial indicators to judge financial risks should include not only financial indicators but also nonfinancial indicators. It also evaluated selected financial indicators using the Zeta model. Wang Zhu Quan et al. (2020) believe that traditional debt risk analysis indicators lack dynamic consideration of corporate debt risk. Enterprise managers and financial workers should evaluate enterprise debt risks objectively and rationally from the perspective of development by combining current policies and market environment. Zhang Yutang (2004) studied the source of enterprise capital, internal capital use, and external capital use. The financial risk of capital is divided into financing, investment, and management risk. In addition, according to the development of financial risks in this study, the development of financial risks can be divided into three stages: incubation period, epidemic period, and high-risk period. Li Ming (2020) used stage symptom analysis method to determine the severity of debt crisis according to events in practical research.

In reading a large number of literature, we learned that because the domestic and international economic development of the country in foreign countries is the earliest, the first to ask the financing and risk to diversify or solve the problem of capital risk is foreign scholars. Some experts in China also drew lessons from foreign research results and had their own ideas. Due to different national conditions and financial environments, researchers in different countries mainly rely on their own national conditions to put forward theoretical perspectives and solutions suitable for their own countries. As the country's economic development is dynamic and the financial environment is constantly changing, some theoretical knowledge proposed by early researchers cannot keep up with the time, and there are many gaps, which cannot really solve practical problems. After that, researchers need to keep up with the times, updating and revising.

The theoretical basis of this paper is as follows: the details of development are divided into four stages. Signs of crisis reveal the stage the company is in. After the judgment, targeted debt risk prevention measures can be put forward. Wang Mei (2020) points out that enterprises adopt Delphi method, and experts and scholars of the organization conduct in-depth research on internal and external

environment, which can determine whether the company has risk factors triggering debt risks.

Data envelopment analysis (DEA) is a nonparametric multi-input multioutput method without estimating production function. This method is widely used by researchers at home and abroad. Foreign scholars have applied DEA method to a wide range of industries (Nasierowski et al. Taghizadehe et al.; Ardakani et al.). Nasierowski et al. established a DEA model and analyzed the relationship between innovation efficiency and productivity in 45 countries. Taghizadeh et al. established a DEA model to divide the company's innovation activities into three stages. On this basis, the impact of innovation strategy on innovation efficiency is studied. Jeong et al., using data envelopment analysis model, analyzed the privacy effectiveness and core work of public organizations and proposed a new model to change personal information security. Ardakani et al. built a DEA model based on panel data from 2004 to 2006 to measure Yazid's innovation efficiency. Based on DEA model, the innovation performance of each region is measured, and it is found that the impact of sales ability on innovation performance is greater than that of technology development ability. Lu Ying used panel data of 11 provinces and cities in the Yangtze River Economic Belt from 2001 to 2006 to measure regional innovation efficiency with a three-step DEA model.

To sum up, the development details are divided into four stages, each with different characteristics. Signs of crisis suggest that the company is at a stage. After sentencing, targeted measures can be taken to prevent debt risks. Wang Mei (2020) points out that entrepreneurs are receiving the Delphi method, where experts and researchers conduct in-depth studies of the internal and external environment of the organization to determine whether the company has risk factors that lead to debt risk. Through reading numerous documents, we learned that domestic and international economic development countries were the first foreign scientists to propose risk financing and diversification or solutions. Some of our country's experts have also borrowed the results of foreign studies and come up with their own ideas. As national and financial environments vary, researchers mainly rely on national realities to provide theoretical perspectives and solutions suitable for their countries. Since economic development is dynamic and the financial environment is constantly changing, some of the theoretical knowledge presented by former researchers is not up to date, and there are many gaps that do not really address the real issues. After that, researchers had to stay informed, updated, and renewed. In addition, scholars have studied the sources of corporate funds, the use of internal funds, and the use of external funds, arguing that the financial risk of capital should be divided into financial, investment, and operational risks, including financial indicators. He also evaluated the selected financial indicators using the Zeta model.

3. Materials and Methods

The idea of DEA is an abbreviation for the decision of the same type of department or unit considered as a unit (DMU); DMU is divided into data as input and output data, forming a set of production potential, finding the production front. In DEA model, the commonly used models are CCR model and BCC model. The difference between these two models is whether the payroll will change or not. The CCR model is constant, and the BCC model is variable. The JRC model is used to measure the overall technical efficiency (TE) of the decision unit and to determine whether the DMU is technically effective. The BCC model not only calculates the overall technical efficiency but also decomposes it into pure technical efficiency (PTE) and scale efficiency (SE). The Malmquist index is commonly used in the analysis of dynamic input-output problems. Malmquist index can be measured by the productivity change in the following two periods. DEA is a static analysis method that does not involve the time dimension; the results obtained are only the effectiveness of each DMU at the same time and do not accurately show the effectiveness of each DMU and its fluctuations at different times. Therefore, to meet the practical research needs, Fare and other researchers developed an innovative idea, the DEA-Malmquist model of productivity indices, which is able to study static changes versus dynamic changes.

DEA (data envelopment analysis) was proposed by Charnes, a well-known operational researcher, in 1978 as an important tool for assessing validity. DEA can be used to assess the effectiveness of multiple decision units with multiple input and output indicators. The relative efficiency of decision-making units (DMUs) is assessed by comparing performance of the same nature, without the need to predetermine the functional form between input and output indicators, and avoiding the possible subjective effects of artificially determined indicator weights. In recent years, DEA methods have also been widely used to assess the effectiveness of poverty reduction in tourism.

The Marquist total factor productivity index was first proposed by Marquist in 1953. Fare et al. combined this index with DEA theory in 1994, and it has been widely used for effectiveness measurement. Since the rate of change of the index measures the assessment of unit benefits based on a distance function, tourism poverty alleviation is a dynamic process. At the same time, the benefits of tourism poverty alleviation are related to the time of rate change. The DEA model dynamically changes the longitudinal trend of benefits for each evaluated unit compared to the static benefits assessment, thus explaining the dynamic nature of benefits change.

There are many indices in the Malmquist index (e.g., Techch, Pech, and DEA), among which DEA shows the evolution of the effectiveness of innovation financing support for high-tech companies. The index of technological progress (index Techch) is used to measure the efficiency of financial inputs to the products produced by technology companies. If the Techch index is greater than 1, it means that the financial input contributes to technological innovation, which means advance; on the contrary, if the technology is less than 1, it decreases. If the Pech index is greater than 1, it means that the financial input plays a greater role in production, and the St value is less than 1, which means that the value of the reduced role is equal to 1, meaning that there is no change in the role played. Scale efficiency (Sech

index) is a measure of the scale of financial support, because the scale factor affects the efficiency of firms in science and technology innovation.

Malmquist productivity and its decomposition indexes are good indicators of the factors of change in the efficiency of innovation. If the efficiency value of one of the decomposition indexes is greater than 1, it indicates a relative increase of the index and plays a positive role. On the contrary, if the efficiency value of one of the decomposition indexes is less than 1, it indicates a relative decrease and low innovation efficiency affecting high-tech enterprises.

4. Results and Discussion

In this chapter, we conducted an empirical analysis of AC, which has become a complementary company specializing in electronic products and electronic systems and electronic content services. The company has gradually developed into a standard provider of design and content services for the electronics industry. AC's long-standing business philosophy and corporate culture is that independent RD and social responsibility are at the core of its operations. Through continuous independent research and development, we hope to open up new business fields so that it can successfully rank among the world's traditional cultural brand companies. In addition, AC will continue to improve its core competitiveness in the international market and achieve sustainable development through the application of a rich and diverse strategic management model, as shown in Figure 2.

As can be seen in Figure 2, earnings are rising year by year in a slow upward trend.

As can be seen from Figure 3, the equity is gradually decreasing, showing a slow downward trend. Demonstrate the ability of the company's investors to use invested capital to achieve diminishing net returns over the period 2016-2021. Although net equity interest rates began to rise after reaching their lowest level in the first quarter of 2021, investor profitability remains modest. AC should find ways to increase operating revenue, reduce the company's costs, and increase the profitability of investors, as shown in Figure 3.

There are many ways to finance a business, usually through a bank or private loan. Depending on the bank's loan product, some require a certain amount of collateral, while others are unsecured credit facilities, as shown in Figure 4.

As can be seen in Figure 4, 2021 has the highest percentage at 31%, followed by 2020 at 22%. 2018 and 2016 have the smallest share, at 10%, as shown in Figure 5.

The current ratio is on a downward trend between 2017 and 2020, with a decrease in the past three years and a relative increase in financial risk. A high current ratio under normal circumstances is associated with strong short-term solvency; on the contrary, it is widely believed that the current ratio should remain at 2 : 1. AC's current ratio is still some distance from the commonly considered good 2 : 1 ratio, and the company still has room for improvement in this area. Based on data from the past five years, the calculated speed ratio shows that AC has not reached 1. Between 2016 and 2020, this shows that AC has acquired fewer and fewer assets over the last five years, with weak liquidity and a decreasing short-term solvency. In 2021, the cash flow ratio is the same as in 2020, and the flow rate is increasing, as shown in Figure 6.

In the past year, this indicator is not above the industry average, but very close to it. The total assets and current turnover of AC companies are relatively stable and have remained almost unchanged over the past five years. Therefore, the operational capacity of the headquarters is close to the industry average, with room for improvement. Improved operating capacity means improved asset delivery capability. When the company's debt reaches its repayment period, AC can settle the debt in time, reducing the risk of bankruptcy and facilitating the company's continued operation, as shown in Figure 7.

According to the above chart, AC's operating ratio is declining although it rebounded briefly, but the overall trend is down, as shown in Figure 8.

AC's sales growth rate and total assets growth rate have not changed much in the past five years and are relatively stable. However, the sales profit growth rate has been negative in the past five years regardless of the changes, which means that although AC's sales revenue has increased every year, its profit has not increased, probably due to high costs or expenses, so AC should pay attention to the management and control of costs. When AC's costs and expenses are effectively managed, its profits will increase, its profitability will improve, the risk of corporate insolvency decreases, and its refinancing ability increases.

To sum up, the mechanism and system framework of investment and financing risks are closely related to the index, and the system framework should be constructed from the index perspective. Financial support for high-tech companies, companies need to always improve the core strength of the team, expand their network, and take advantage of their own strengths to become the trendsetter of the times, and major technological innovations in high-tech companies often require long-term and large-scale investment. In the process of innovation, we should actively learn from the positive experience of other institutions, increase our own financial income, and adapt to our own development stage; adjust the structure of financial assistance to adapt the industrial structure to industrial development. Although the times are progressing, do not mess up your own footsteps because of this, but improve your own literacy and keep up with the times.

Our countries are currently in high demand, although there are more advanced systems in the financing market, but at the current stage, countries are developing independently, to have their own core strength and to constantly improve themselves; to the financing of stocks, first, actively promote stock market financing, and optimize the favorable conditions for public enterprise financing. The other side of the company expands the financing channels, such as expanding the financing channels of the company, and actively encourages high-risk investment, high-tech enterprises, or high-tech enterprises to support the venture capital fund and financial support for high-tech enterprise innovation and accelerate the establishment of a system of risk. In order to better serve the needs of financing high-tech

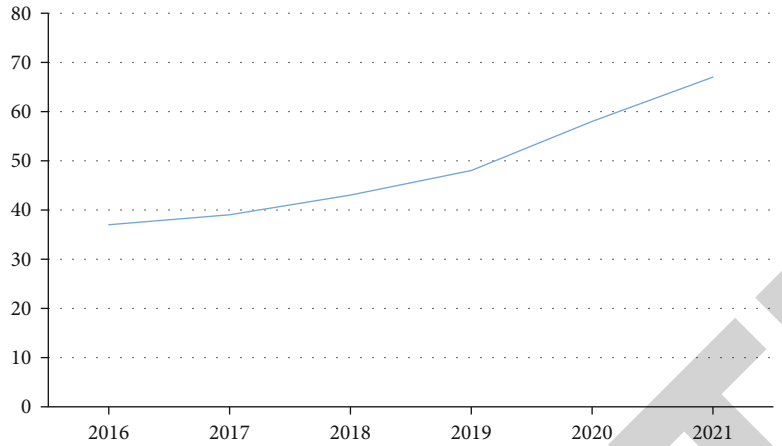

Figure 2: Trend of earnings change.

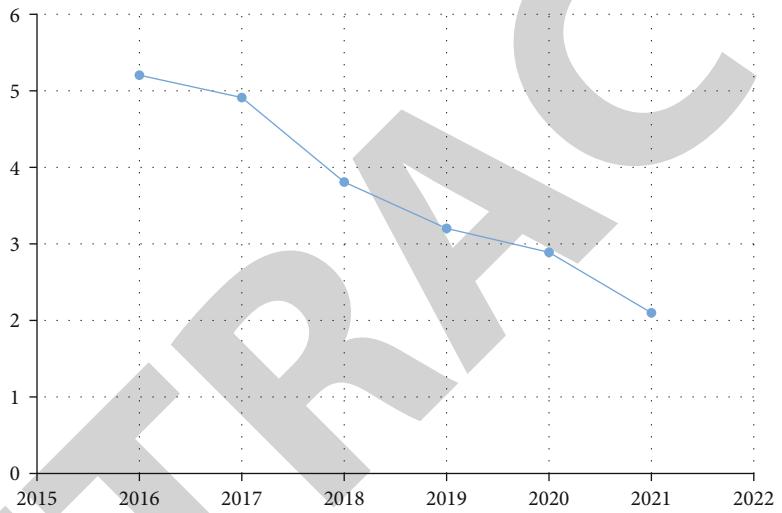

Figure 3: Change in equity.

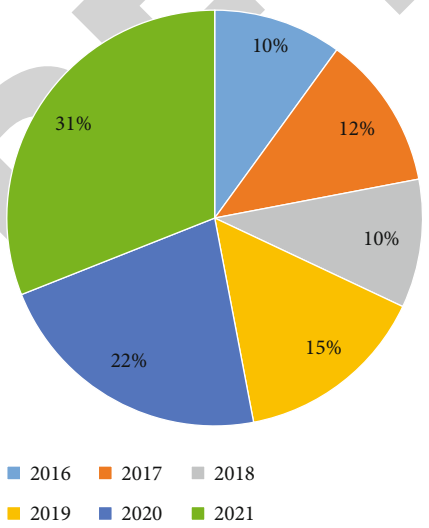

Figure 4: Percentage of equity by year.

companies in the capital market, the offer must meet the needs of all kinds of high-tech enterprises through the reform of the capital market system, such as the opening of the China Council in 2019. In addition, legal mechanisms must be established to continuously improve China's capital market, increase the institutional mechanism for sanction violations, and play the capital market function to defeat high-tech enterprises while avoiding wasting state funds. More attention should be paid to these needs of small and medium investors to attract free social funds to high-tech enterprises and improve the efficiency of the use of the free part of social funds.

Credit support from commercial banks to high-tech enterprises accounts for a large part of market-related financial support. Credit intervention is very good only when high-tech enterprises are underfunded in the innovation process and have a very serious shortage of funds. To a certain extent, it reduces the strength of control over high-tech enterprises. In terms of innovation, it is important not to just innovate without implementation, but to combine the market situation and be on the ground, while for banks,

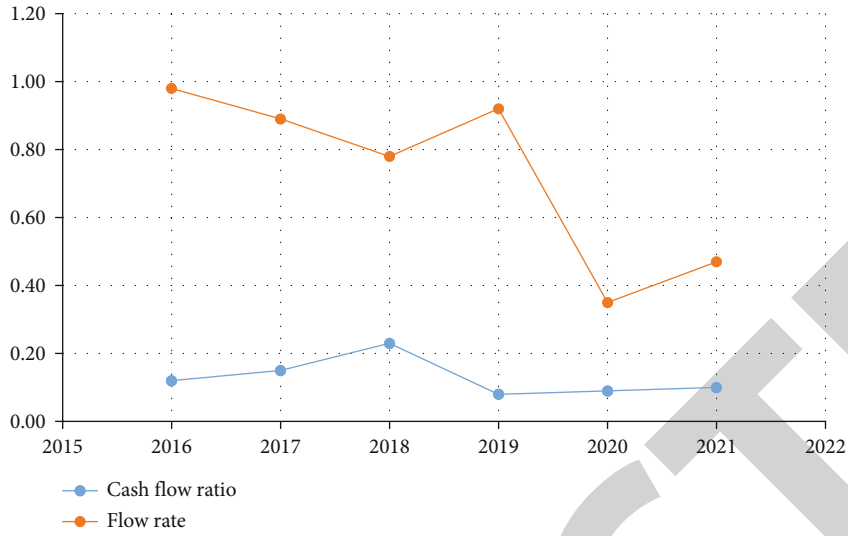

Figure 5: Trend of short-term debt service indicators.

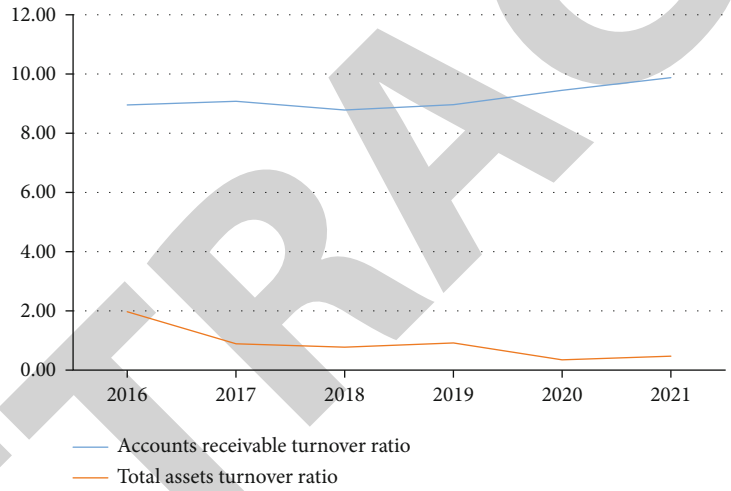

Figure 6: Trend of operating capacity indicators.

the optimal loan terms, to establish policy-oriented financial support usually in the form of direct subsidies that are neither openly used nor effectively controlled and managed. First, in order to avoid wasting the finances of politics, both sides must combine government and market forces, play a role in market disclosure and resource allocation, and improve the transparency of political instruments. On the other hand, strengthen the management, implementation, and approval of budgetary funds policy and the establishment of internal control and balance mechanisms; clarify the process of responsibility of different actors; strengthen the monitoring of the use of funds and government information; and subsequently, improve the efficiency of the use of funds.

In terms of government, the government can create a legal environment conducive to innovation in high-tech enterprises; improve patent laws, trademark laws, and copyright laws; and provide a legal basis for various property transactions. For example, special bank lending policies can promote high interest rates by reducing the costs of high-tech enterprises, innovation and improvement in the use of financial instruments under pressure high-tech enterprises and the development and innovation of enterprises. Optimization of the model of implementation and training of human resources is aimed at improving the level of social security of researchers, strengthening incentives for the development of human resources, and promoting greater transformation of innovative results. In addition to this, companies that can expand financing channels, such as companies that expand financing channels, actively encourage high-risk investment, high-tech enterprises or venture capital funds that support high-tech enterprises, and financial support for high-tech enterprise innovation, accelerate the establishment of systematic risk, and prevent systemic risk, so that companies must combine government and market forces and play a role in market disclosure and resource allocation to improve the government's transparency of political instruments.

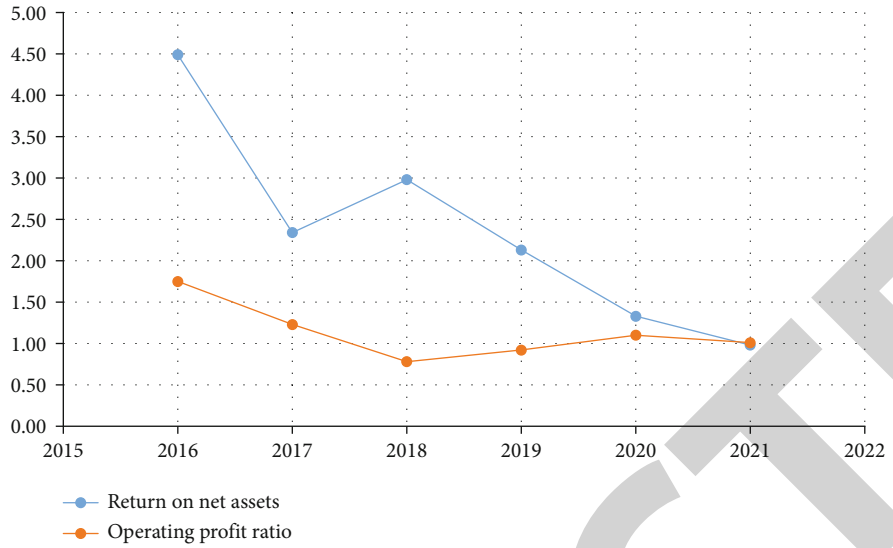

Figure 7: Trend of profitability indicators.

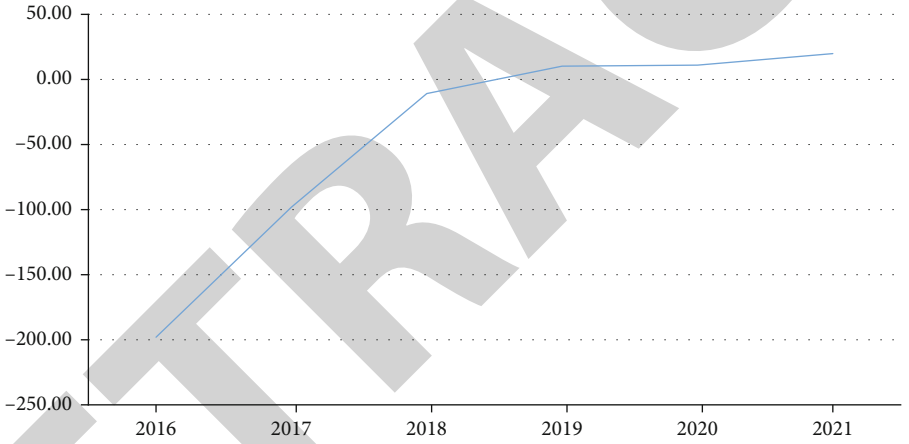

Figure 8: Sales profit growth rate.

5. Conclusion

5.1. Conclusion. This paper discusses the complete data of 537 panel data of Chinese high-tech enterprises from 2016 to 2021, with China index model, and used DEA-Malmquist for empirical analysis and financial support for high-tech enterprise development and obtained the following conclusions:

(1) First, there is a strong correlation between the 8 input indicators used and 5 output indicators; as can be seen by the graph, total factor productivity shows an upward trend, while the rest of the indicators do not change significantly; some years less than 1, but close to 1, there are remaining years that innovation efficiency has decreased. Among the factors of these, total factor productivity (TFP), because of the influence of some factors, was subject to fluctuations in the years of lower efficiency of technological progress, resulting in the fluctuations of these two factors show a certain degree of interdependence

(2) According to the average level of different industries working high-tech companies and their indicators as well as financial support for innovation, effective companies are at a level too low; in turn, through new technologies means that many industries have to transform as a result, because the market is advancing while technology has fallen behind and backward technology can not meet today's situation. In addition to the traditional high-tech industries, where the total factor productivity is higher than 1, the total factor productivity (TFP) of enterprises engaged in electronic information technology resources, with the surrounding environment biotechnology and new pharmaceutical technologies engaged in aerospace enterprises, is lower than 1; the space demonstrates the more obvious positive

effect of financial support for innovation in high-tech transformation of traditional industries, taking into account the resources and environment of technologists, biotechnologists, and new pharmaceutical technicians. Experts should focus on innovations in three areas: resources, environment, and aerospace technology, aerospace technologists should improve innovation in these three areas. The speed and the optimization of the financial support structure can also contribute to the financial optimization

(3) Statistics on excess investments and excess products of high-tech companies show that the electronic information industry has the highest number of investments and excess products and the lowest reserves of resources and environment. The effectiveness of DEA can be achieved by adjusting the relaxation variables for each firm

(4) In the specific analysis of the output investment indicator, it was found that the investment index has a large number of researchers, and that the companies finance their own investments, while financial support to the market is low. The output index is not high enough, and the income is not clean enough. This reflects the irrational structure of financial support to high-tech companies and the inefficient use of financial resources. At the same time, the study shows that high-tech companies must restructure their sectors and increase the number of researchers; companies have their own financial flows as financial support to ensure the most efficient financial support for high-tech innovative companies and the financial support policy for the size of the inflow of companies' own funds to achieve the best efficiency of financial support for high-tech innovative companies.

5.2. Suggestions. In summary, this paper provides the following suggestions for better establishment of the financing risk mechanism: mastering the key point of science and technology to promote the country. The prosperity of science and technology includes the prosperity of talent. At the same time, we should know that talents are the basis for the development of the country, and enterprises should grasp talents and cultivate them, while giving talent programs, such as the management trainee model, should be further implemented, without generalizing just empty words, to be implemented in practice and really provide a good environment for talents. With the financial support of high-tech companies, the company must constantly optimize its internal management mechanisms by forming a professional management team within the company to follow the changes and phenomena that have occurred over the centuries in order to avoid spending money on research and development due to blind investments. High-tech technologies are constantly advancing, and the world is becoming economically depressed due to the development of the epidemic. In this situation, home working is starting to emerge, and people are trying to resume work in different ways, such as online meetings, in the expectation of improving economic efficiency and meeting people's requirements.

Data Availability

The dataset is available upon request.

Conflicts of Interest

The author declares no conflicts of interest.

Acknowledgments

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Retraction

Retracted: Spatial Expression of Multifaceted Soft Decoration Elements: Application of 3D Reconstruction Algorithm in Soft Decoration and Furnishing Design of Office Space

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] P. Yao, "Spatial Expression of Multifaceted Soft Decoration Elements: Application of 3D Reconstruction Algorithm in Soft Decoration and Furnishing Design of Office Space," *Journal of Sensors*, vol. 2022, Article ID 5345293, 11 pages, 2022.

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Research Article

Spatial Expression of Multifaceted Soft Decoration Elements: Application of 3D Reconstruction Algorithm in Soft Decoration and Furnishing Design of Office Space

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In China's modern market economy under the rapid development of the general situation, we work more and more problems, and work pressure is also increasing. The so-called office space refers to the space layout, style, and the physical and psychological division of the space. Office space must take into account many factors, involving technology, technology, humanities, aesthetics, and other elements, while the office space is the space where people work and relax. In recent years, as people's requirements for the work environment are increasingly high, therefore, the design of the office space is also more and more attention to people. The concept of soft furnishing design into the work space will help improve the overall corporate and office space design of cultural taste which is one of the main methods to show the quality and human connotation of the enterprise. The three-dimensional reconstruction refers to the creation of a mathematical model suitable for computer display and processing of three-dimensional space objects. It is an important basic tool for data processing, computing, and researching the performance of mathematical models in the computer environment, which can be applied in various fields such as autonomous navigation of mobile robots, aviation and remote sensing computing, industrial monitoring information system, medical imaging, and virtual reality. The 3D environment reconstruction technology has become one of the popular research areas in computer vision and increasingly attracts the attention of design practitioners. This paper takes the 3D environment reconstruction technology of office space soft decoration design as the basis and discusses the important elements and modeling ideas in soft decoration design, which adds to the interior design of office space, and uses Kinect to obtain the depth data in the 3D environment, so as to complete the realistic 3D reproduction of the interior environment based on computer vision technology.

1. Introduction

In the interior design of the soft furnishings, in addition to the aesthetic conditions, we must also take into full consideration the ergonomic type of demand and try to meet the user's needs in various aspects of use, in order to design a more scientific interior environment, office space in the actual design, generally using a combination of all types of design models, from the cultural profound connotation, visual effects, and technical aspects of the environment to optimize. The application of 3D reconstruction algorithm in the design of soft furnishings in office space contains several points, namely, furniture, materials, lighting, furnishings, and colors. What kind of objects to meet the needs of interior environmental art design is a very important choice.

2. Research Background

The specific attributes of multifaceted soft furnishing elements are divided into two types. The first one is practical functional statement and decorative furniture. It is the application of 3D reconstruction algorithm in the design of soft furnishings in office space, As far as the early stage is concerned, this kind of decorative art can meet the spiritual needs of users. According to its own style and characteristics, it will be arranged to the corresponding place, to play a

differentiated effect, so that the exhibition landscape shows different characteristics. For example, many decorative artworks, textiles, and ornaments (hanging decorations in the air, hanging paintings, hanging on the wall, etc.) are in the indoor environment. Also, it includes the integration of some prehard parts and soft furnishings [1].

Secondly, practical functionality is introduced. Practical functionality is provided for various human behaviors in using interior spaces and is subject to various factors such as human-computer interaction, size, and convenience of the furnishings so that people can better use and access such furnishings. Therefore, the appearance, shape, color, size, touch, and material of these soft furnishings should be carefully designed to meet the different requirements of decorative art and application effects.

According to the spatial expressiveness of multifaceted soft furnishing elements, the specific categories of items in art and design are further divided into four subcategories, and their specific use in public interior spaces is highlighted. First is the main landscape, including the visual center of the various landscapes. The main landscape is usually in the public interior space, i.e., the overall space of the theme. Using abstract or concrete landscaping techniques or methods, it may, of course, be designed as a landscape or as an indoor water feature. Of course, it may also be located on the main wall of the floor or floating in the air. Its size is usually quite large. Second, it serves as a backdrop, echoing the thematic background of the interior space. The purpose of its existence is to match the main landscape of the building, so that the entire interior space constitutes a strong effect of hierarchy, while reflecting a sense of coherence and integrity.

In the soft design of office space decoration, people should ensure the integrity and authenticity of the use of color: color plays a key role in creating the space environment, highlighting the tone of the space, a reasonable combination of colors to create the right space. For the full use of color, it is necessary to understand the basic characteristics of color, in order to more effectively use the special attractiveness and value brought by color. Because different colors, with different characteristics, different spatial effects. Full use of the number of colors, in order to let us in the space environment and color combine harvester aesthetic way and medical way, get great pleasure and enjoyment. And with the development of the times, the color used in the design of office space is no longer simply cold tones but also increasingly diversified. Different shades are selected and beautified according to the different requirements of each work type to improve efficiency [2].

3. Office Space in the Form of Expression of Soft Furnishing Design

3.1. Furniture. The proportion of furniture in the design of the entire office space is also quite large, so the choice of furniture plays a key role in the overall design of office space decoration. In other words, the design of furniture will be related to the determination of office furniture style, and different furniture can show a different style. The size of the furniture should be in accordance with the size of office furniture to decide. If the furniture is too big and bulky, the space will become narrow. Therefore, in the space of low floor height, slender furniture should be used. From the material, wooden furniture will bring people a comfortable and free feeling, while the fabric home will bring people a warm and affectionate feeling. The Ming furniture rigorous shape, elegant curves, and rich historical heritage are able to give humanistic meaning to the design of office space.

3.2. Material. In the design of office space, the choice of materials is also very critical, because very different materials bring people to a very different feeling. Marble in the office space design has a very obvious interior decorative effect, different colors and natural colors bring a strong visual impact, high material hardness and good wear resistance should not be dusty and easy to maintain and repair, and long life is the key to the choice of office space design materials. In addition to the office space as furniture, wood panels in the floor and wall also have a great decorative. The use of wood finish flooring has the advantages of winter warmth and summer cool, higher comfort characteristics. Stainless steel gives a cold impression, while mirrors can make the space look bigger. Different materials have their own characteristics advantages. In accordance with the characteristics of the office space decoration, the choice of suitable materials is not only to release the flavor of the material but also to create the environment of the office space, so that staff live in a suitable space more effective office [3].

3.3. Lighting. The choice of lamps and lanterns, the overall lighting, and atmosphere of the office space plays a decisive role. Therefore, the shape of the lamps and lanterns should be in harmony with the overall space, and the color of the lamps and lanterns should be in harmony with the overall color of the space. Lighting mainly includes cold and warm, two categories; cold light gives a sense of calm, while warm light gives a sense of warmth. In the light, there are direct light source and indirect light source. Set up a desk lamp at the desk in the office, that is, professional and beautiful. Installing corner lamps around the ceiling can improve the safety of the room and increase the efficiency of the personnel. At the same time, indirect lighting can reduce the impact of visual glare brought by direct lighting.

3.4. Furnishings. Furniture is a kind of decorative or artistic value of building materials used to beautify or improve the visual effect of the indoor environment. The decoration of furnishings will be able to improve the saturation of the space, so that the entire space does not give a cold impression, and the humanistic connotation and sense of the times permeated from the interior furnishings will be fully reflected in the design of the entire space.

3.5. Color. Color can be seen everywhere in the design of office space, which is the carrier and core of the design language. It can produce a visual intuitive experience and spiritual shock. Color in space also has the function of distinguishing the level of space, increasing the sense of space hierarchy, with different colors can be expressed in different

spaces, so that people can understand at a glance. Color can also bring us a great visual shock, play a guiding role, and make people unforgettable. Color and furniture, color and material, etc., will create a very different style of office space. Usually, red bedroom will make people feel warm, blue bedroom will make people feel cool, and this is because the color brings a different mood experience. There are many colors to choose from in the office, including white and gray, blue and green, and brighter colors. In summary, the choice of color has broken through the previous dull, boring feeling, and full of vitality and vitality of the color is the ideal choice for modern office space design, but also to provide staff with a vibrant and interesting office space.

3.6. Plants and Lighting. Plants have the function of organizing space and enriching the level of office space. The use of greenery as decoration in an office space can subtly separate the space and make the whole very transparent, which is both a whole and a clear division of labor. Placing greenery in the corners of many spaces, accenting the space and punctuating inconspicuous corners, brings the space to life. Most modern offices are dominated by geometric lines and shapes, giving a strong sense of space. The unique attributes of plants and natural lines are integrated into the space. The contrast between rigidity and softness not only influences the visual effect but also enhances the overall aesthetics of the form. Artificial lighting must be achieved by using artificial lighting tools as light sources, while natural lighting must bring natural light from the outdoors into the interior space, mainly monotonous lattice lights. The space atmosphere created by this monotonous bright environment design is also monotonous. Therefore, in the modern office space design, the design of bright environment is gradually getting attention.

At the same time, the reasonable combination of lighting in nature and artificial lighting can reduce the energy consumption of the building while ensuring the use of lighting. The natural light of the building enters the building mainly through the steel roof and windows. Below the awning is the atrium of the building. The high luminance lighting not only meets the daily working needs but also adds volume to the space. The light projects the steel structure onto the atrium and walls, making the interior space more interesting. Daylight from the windows passes through the exterior surfaces of the building. In this case, smart umbrella technology is used on the surface. An active outdoor umbrella was created through a rational analysis of height angles and the daily path of the sun in winter and summer and through a comparative analysis of outdoor umbrellas of different shapes, sizes, and angles. On the one hand, the solar lighting of the building should be considered to avoid glare and insufficient lighting. On the other hand, it is important to avoid large amount of sunlight, which increases the load of indoor air conditioning. At the same time, the umbrella also has the advantages of sealing, considering ventilation shading, increasing wind resistance, and combining automatic smoke exhaust and ventilation and fire prevention, as well as multiple opening methods. Artificial light sources mainly use fluorescent lamps and LED lamps, and choose different lights and color temperatures according to different space functions to highlight and express the space atmosphere. In the office space, each work unit in the work area uses high point light source to provide lighting conditions for work activities, and the point light source is of great help to the concentration of employees.

The use of luminaires plays a vital role in the overall lighting effect and atmosphere of the office space. Therefore, the shape of the lamps and lanterns must be compatible with the overall space design, and the color of the lamps and lanterns should also be harmonized with the color of the overall space design. There are hot and cold lighting, cold light gives the impression of cold, while warm light gives the impression of warm. In terms of lighting, it is divided into direct light source and indirect light source, in the office desk, install a direct table lamp, both professional and aesthetic, and the installation of indirect lighting around the ceiling improves the comfort of the room, thereby increasing the efficiency of staff. In addition, indirect lighting can also reduce the glare hazard to the eyes due to direct light.

The color temperature of the communication space is mainly warm light, which can make the indoor space become soft light and space to form a warm and friendly atmosphere. Studies have shown that in offices with uncomfortable acoustic environments, people have high adrenaline levels and work under stress, which negatively affects their health and psychology with symptoms such as headaches, irritability, and neurosis. Therefore, a good environment is crucial for a new office. How to create a relatively quiet working environment, the design uses soundproof sponge words, and effectively reducing outside noise interference can improve the concentration of employees. On the other hand, in the division of the internal space of the building, there are noisy functional areas, such as dining room, exhibition hall, press room, and activity room [4].

Material is a specific vector of space, and its characteristics include color, texture, texture, and intensity. Using these features and user interaction, visual and tactile interaction is the most important way to interact with people through good material design. Raw wood, raw cement, and various different textures and shapes will give people a different psychological experience, so that each good material can be set up to show the mood and value of a space in a more comprehensive and three-dimensional way. With the increasing maturity of modern science and the improvement of human life, the material will flourish towards green and lightweight, finished products and standardized construction. The green color comes from nature. Trees, flowers, and leaves can bring life to life and increase interest in life. Bringing nature into architecture creates endless vitality, which is especially important for urbanites who have been away from nature for a long time [5].

In the past, when we did research on green space design, we often learned how to use spatial devices such as space drills to increase the speed of greenery planting. Certainly, these measures are understandable and effective. However, with the continuous development and evolution of advanced technology and environmental protection concepts, modern new offices set measures in building green design not only

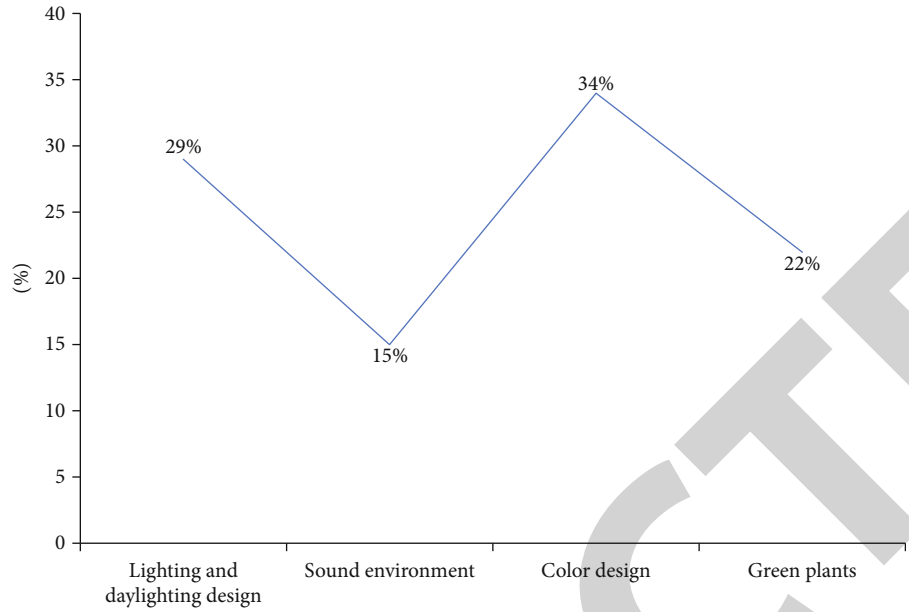

Figure 1: Survey map of the evaluation index system of the earth state beauty landscape.

limited to introducing green improvements, but also planning and rational planning, energy recovery and energy efficient building, energy saving and emission reduction, and purifying indoor air. Adhering to green roof technology, the use of green roof technology refers to the green plants on the roof area away from the ground, which not only makes the roof functional and entertaining but also serves as a specific heat insulator, reduces the heat island effect, effectively controls the local climate on the roof, and reduces the energy efficiency of the building, as shown in Figure 1.

4. Materials and Methods

The special feature of machine vision is its complexity and incompleteness. The pioneers in this field can be traced back to the early days, but it was not until the late 1970s that machine vision technology received real attention and development, as computer performance had been enhanced to allow for large amounts of data processing such as graphics. Computer vision combines the use of image information processing, model recognition, artificial intelligence, and other high and new technologies to analyze the image information obtained by a single or multiple sensors to determine the target and judge the body parts and postures of the target, which eventually allows computers to see and cognize the world directly as humans do and has the ability to actively adapt to the environment [6].

3D reconstruction information technology based on image vision refers to the use of digital cameras as image sensors and the full use of image information processing and image information processing to form a noncontact 3D sensing technology to view images. The 3D data of an object is obtained from a computer program [7]. As the main branch of machine vision technology, 3D reconstruction based on visual features has been modeled with many techniques based on the conceptual framework of Lamar vision. For example, they can be subdivided into area-based techniques, feature-based, pattern-based techniques, and rule-based techniques. Depending on the form of the acquired data, it can be divided into active field and field methods, and depending on the type of camera, it can be divided into especially microscopic telescope techniques, using a single visual 3D reconstruction technique, as shown in the demand analysis diagram in Figure 2.

The 3D reconstruction module is divided into three modules: the visual data collection module, the SLAM algorithm implementation module, and the 3D reconstruction module. The visual data function mainly performs Kinect's ability to collect images. The related functions mainly involve Kinect controller, Kinect camera color scale and infrared camera, color mapping of Kinect collection, and depth map collection. This function mainly extracts the image data corresponding to the other two functions; in the role of SLAM algorithm, it mainly involves two aspects: image generation and camera position adjustment. The main purpose of map creation is to transmit visual information through Kinect, detect visual landmarks on the image and complete matching, and finally perform the map creation function. The camera positioning function is used to predict and correct the EKF by means of preset motion patterns and observation modes. Finally, the determination of the camera pose, the creation of the map, and the camera localization are three simultaneous processes. The map provides a clear visual reference point for the camera's position. The camera positioning process determines the camera position based on the coordinates, visually identifies the position events, and creates a more accurate map model. In the algorithmic model of 3D reconstruction, the preliminary functions of point cloud repositioning, point cloud compression, and 3D rendering are completed. The camera position is correct, and the definition uses a sliding algorithm to obtain the current frame, and then, the current point cloud is transformed into

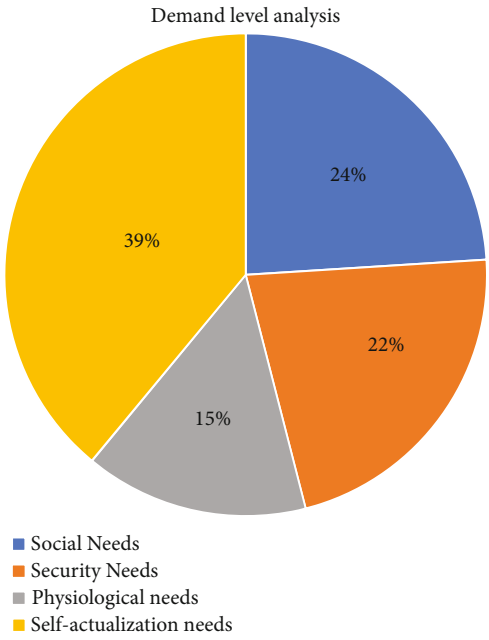

Figure 2: Hierarchical analysis of needs.

the global coordinate system, and the point cloud can also be transmitted in real time through Kinect for time updates and 3D rendering [8].

5. Application Example Analysis

5.1. Research Object. In the process of 3D reconstruction based on computer vision, one of the key steps is to establish the correlation between different image function points. There are also many image matching methods, but they usually include the following two: one is the result of matching from feature points; however, there is also a grayscale matching method [9]. Feature matching methods start by acquiring features in the original image, which can be points, lines, regions, etc. It has significant features. Matching techniques based on image information are generally classified into more advanced matching, such as image point matching, boundary matching, and closed boundary matching; grayscale matching method is also known as correlation matching method. The main point is to use spatial two-dimensional slip model for image matching. Different algorithms make different judgments about the correlation model and criteria. There are many kinds of grayscale matching methods, and normalized correlation (NCC) is a classical angle matching algorithm. The central idea of NCC angle matching is that, assuming that angle a in image M is the same as angle B in image N relative to the same focal point in space, the condition of similarity in position must be satisfied by adjacency in a and B. The basic principle is to measure the rate of change of gray value of each element in the nearest neighboring frame to the center point. It is a window in which the images are matched by correlation coefficients in the reference image and kernels with feature points. In the image to be recorded, a corresponding window of the same size as all feature points in the sequence is set. The grayscale values of the two windows are combined and entered into the correlation coefficient formula for calculation [10]. The maximum size of the area window T is $(2l+1)*(2k+1)$, and the window size $(2h+1h)*(2w+1)$ is taken to the angle B in the image n. When the image m is taken, the position of the point B in the graph n is taken to be the center, and it is noted as the search area s. Then, the normalization between the area window T and the search area s is related to each other, and the maximum size of the model area is related to the search area $(2l+1)*(2k+1)$, called the SUV subgraph, where (U, V) is the image coordinate of this subgraph in M [11]. If the angle a in s in the search region is greater than the set threshold, it is assumed that a in the image m to be recorded corresponds to B in image n, which is the same point in space, as shown in Figure 3.

When the center of T lies at the boundary of the image m to be recorded, an adaptive Kalman filter needs to be extended around the boundary of m. It is a theoretical tool used to create synchronized localization systems and maps for mobile robots, and its basic principle is essentially the same as that of the standard adaptive Kalman filter, i.e., it is based on the principle of small variance linear estimation and uses a recursive algorithm to estimate and extract information about the values of interest in measurement-related information [12]. The estimation process of the state equation at moment k for the whole operation history of the EKF is as follows:

$$x_k = f(x_{k-1}, y_{k-1}, w_{k-1}), \tag{1}$$

$$z_k = h((x_k, v_{k-1}), \tag{2}$$

where the random variables are $k\,k\,w$, v represent the excitation noise and observation noise of the procedure, and the nonlinear variable f in the state equation reflects the state at k negative one time at the current k time, and in reality, we also estimate the state vector and observation vector by setting them to zero at each time $k\,k\,w$, v value, when actually processing [13]. In the process of 3D reconstruction based on computer vision, one of the key steps is to establish matching relationships between feature points of different images. There are many ways of image matching, but two types are usually distinguished: the first type is mainly based on the matching of feature points, and the other type is generally based on the matching of grayscale. In the feature matching method, firstly, information is required from the original graphics, and these features can be points, lines, regions, etc., with significant characteristics. Then, the matching and correspondence methods between the features of the two graphics are determined, and the correspondence methods according to the graphic features generally include image point correspondence, contour shape correspondence, closed contour shape correspondence, or higher-level feature correspondence; its use of grayscale matching is also called the corresponding matching method, and the essence of the method is the two-dimensional slide template in space different methods have different methods to determine the template relative criteria. The core idea of NCC corner point

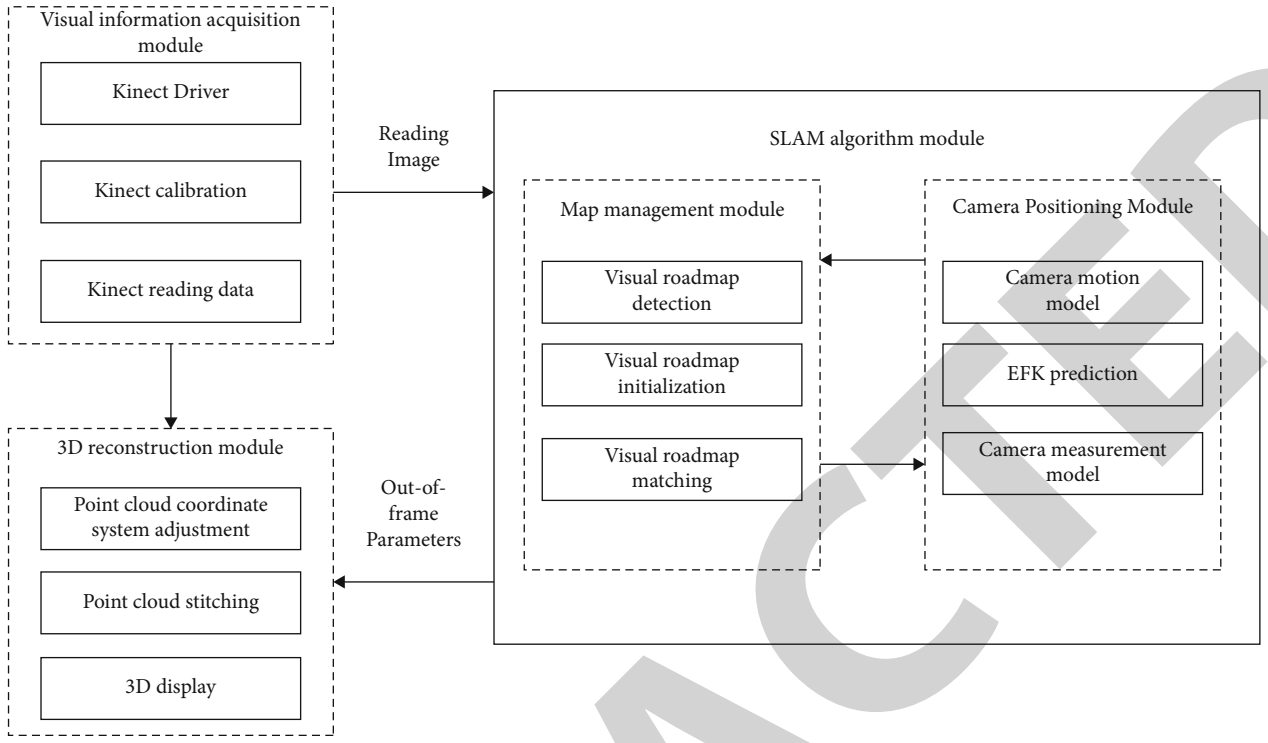

Figure 3: Schematic diagram of DRNN structure.

matching is that if the oblique point A and n pixel points of image m correspond to the same node in the corresponding space at the oblique point B, then A and B and all their neighboring nodes satisfy the medium grayscale similarity constraint, and the basic principle is to estimate the similarity of grayscale values of all pixels in the neighborhood of the oblique node in adjacent frames. It is to use the correlation coefficients therein to achieve image matching. The movie point centering function opens a set of windows where the part is to be registered, creates windows of the same corresponding size at each feature point in turn, and then inputs the grayscale values of the two windows into the corresponding coefficient formulas for calculation [14].

5.2. System Flow. In the software development process of single target vision slam technique based on Kalman filter, the first step is to predict the situation of the system in the next motion pattern to obtain an a priori estimate of the system state, while the second step is to analyze the tendency of the real-time picture through fast algorithm and match the detection tendency through NCC corner matching system to obtain the visual signposts in the scene. The third step is to measure the visual landmarks in the environment obtained by combining the cameras according to the prior state prediction, and the EKF is substituted into the measurement model to update the state of the calibration system. When a single camera is used, the depth information of the feature points in the environment cannot be obtained by observation, and only the orientation information can be obtained. Therefore, it is processed using the method of initializing the depth from the literature and the first observation of the corner points. The mobile robot only knows the position of the corner points in the beam, which is an effective method [15]. The ray uses the associated covariance matrix of the conic probability distribution function to represent the position of the corner point. In the process of gradual approximation, the inconsistency and variance of the corner point positions gradually decrease, and the depth value of the corner point is finally estimated. In the fourth step, we propose a delay-free initialization method to obtain the feature point depth information. In the fifth step, if few feature points are detected in the environment and the feature map is poorly described, we should initialize new corner points [16].

The above five steps are approximate EKF-based monocular vision SLAM processing, and the whole software flowchart is shown in Figure 4.

The EKF-based SLAM algorithm can achieve the purpose of tracking the camera position and feature point coordinates in the localized environment. The coordinate systems used in this document after processing include graphic coordinate system, image plane coordinate system, camera coordinate system, and world coordinate system. We define the width of the black partition with a neighborhood size of $21.0\,(\mathrm{cm}) \times 14.85\,(\mathrm{cm})$ as the x- and y-axes in the world coordinate system, perpendicular to the z-axis of the partition plane [17]. For the purpose of this paper, based on the experimental data concerning the structure-building software operating system of monocular field of view SLAM using EKF and the design of the real-time 3D structure reconstruction algorithm of monocular field of view SLAM using Kinect, the area of the circle in the figure is its uncertainty, which gradually decreases under multiframe image correction processing, i.e., the area covered by the circle

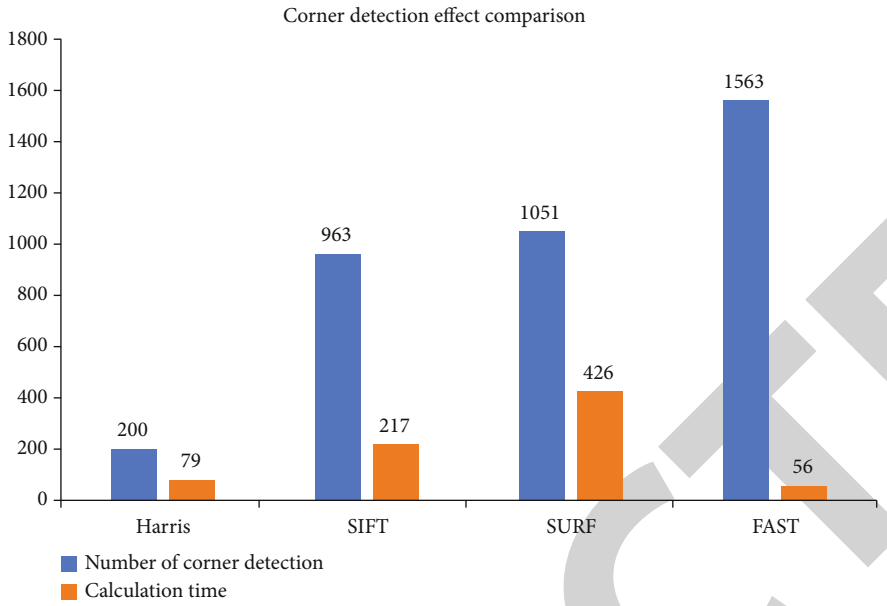

Figure 4: Comparison of corner point detection effect.

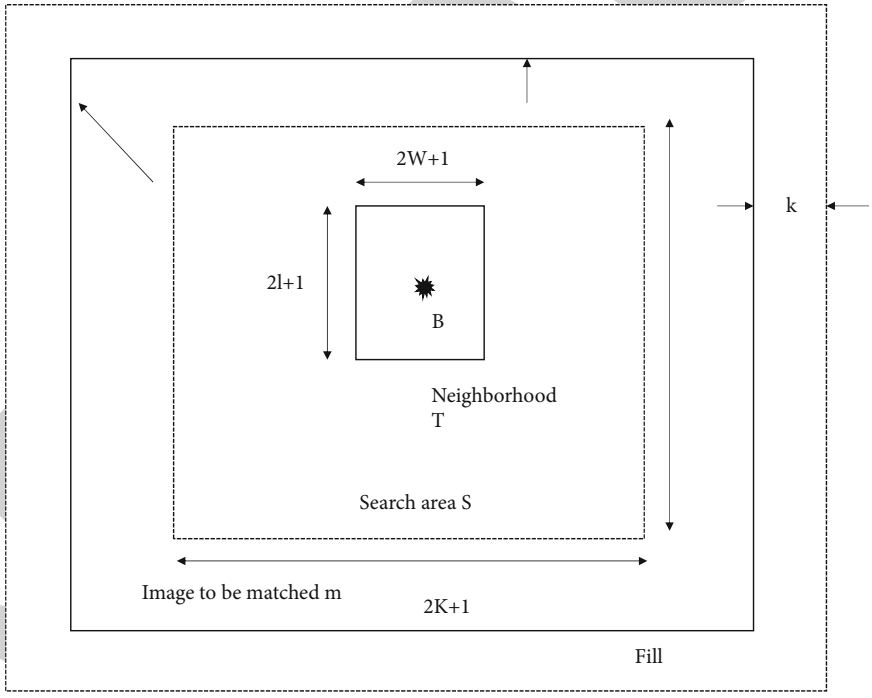

Figure 5: Training data analysis graph.

decreases. Finally, we mark the feature points that have been successfully located with crosses, as shown in Figure 5.

Compare the 3D reconstructed point cloud results and material selection of SFM algorithm, Kinect algorithm, and EKF-SLAM. We can see that the locations are empty, and the algorithm needs to process a large amount of data for matching. In this paper, it took a total of 8 hours to process 306 images and achieve the 3D reconstruction.

The 3D reconstruction of the internal environment based on simultaneous localization and map building algorithm proposed in this paper has fewer real-time features and weak textures, but no phenomenon was detected during the 3D reconstruction. After an extensive comparison of 3D reconstruction based on optical flow tracking computation and SFM algorithm, this paper concluded that the 3D reconstruction technique based on Kinect and EKF-SLAM can achieve good real-time and reconstruction results [18]. 3D reconstruction of internal environments is also a key topic in computer vision, especially in the fields of VR, machine navigation, and entertainment life. In the paper, we focus

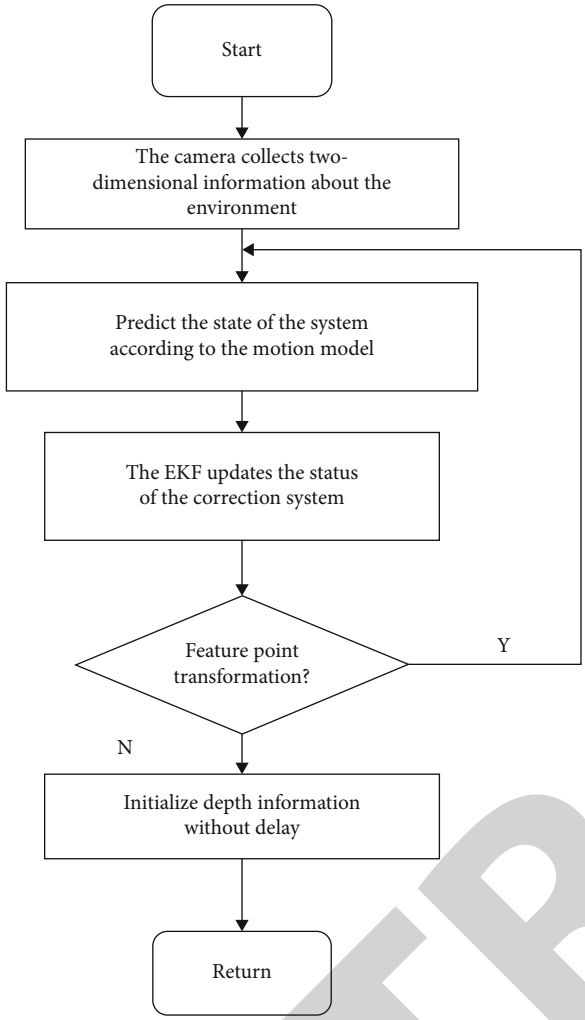

Figure 6: Element analysis diagram.

on the 3D reconstruction of internal environment and finally finish the real-time 3D reconstruction of internal environment, which lays the cornerstone for the future development of navigation and orientation robot, as shown in Figure 6.

It should be especially noted that in the 3D reconstruction method based on Kinect and EKF-SLAM given in this paper, Kinect is introduced to actively acquire depth information in the environment, rather than the depth of the initialized boundary marker is delayed in the visual slam. Therefore, feature point conversion and delayed initialization are not required, as shown in Figure 7.

Take a region window T of size $(2l+1) * (2k+1)$, centered on angle B in image n, and a window of size $(2h+1) * (2w+1)$, centered on the relative position of point B in image n in image m, recorded as SUV subgraph, where (U, V) is the coordinate of this subgraph image in M. If the angle a in the search region s is higher than the set threshold, A in the image m to be recorded is considered to correspond to B in image n, which is the same point in space [19]. When the center of T is located at the boundary of the image m to be recorded, it must be around the boundary of m. The design of office space should adhere to the basic principles of space optimization, functional perfection, personalized design, and environmental purification. Soft decoration design should understand the influence of different decoration styles, their typical characteristics, and requirements for the design style. In the soft decoration design, no matter what style, we should do the correspondence and proportional relationship between the main, main background color, main color, and decorative color [20].

Nowadays, people prefer to advocate humanization, use certain artistic expressions to express their interests and preferences in the space, and set up artistic personalized business cards, highlighting the principle of people-oriented. In modern soft furnishing design, we should observe from many directions and angles. After establishing the design, you need to find the most suitable soft furnishing factors for the design. Materials, colors, and contrasts should all be balanced and consistent. Do not cover too many elements in the design. Choose the best from the best. Choose the right one. Too much decoration can make the furniture look too full. In the method of placement, it is not necessary to observe the principle of asymmetry, but you can also follow the basic principle of symmetry to find variations and make the space interesting. The design and development of office space products is a long process, always aimed at meeting the needs of their users, i.e., employees and companies. Very different social and historical periods have very different temporal characteristics. The architectural design of office space must not only meet the main functions of society but also keep up with the times, integrate the spirit of the times and entrepreneurship, and link the productivity of the enterprise with the productivity of society. In this way, we will be able to create a new kind of office space that meets the characteristics of the times and the needs of enterprises.

In this paper, we use Kinect depth mapping and color image technology, and the digital generator cannot generate information until the command requirements are determined. Among them, function generation can be started by operation, while data generation can be paused by function but without releasing node data; so far, it has been possible to read content produced by different efficacy key points. The different output keypoints correspond to various matching function formulas. Therefore, the depth generator used in this paper reads the depth data through the function of data generator; since the information generation element continues to receive new information and the application program may also adopt the original information, all the generation elements will keep the new information in the system during the actual information acquisition process until the explicit instruction of new information is obtained, and the whole acquisition processing flow is shown in Figure 8.

6. Conclusion

6.1. 3D Reconstruction Perspective of Interior Soft Furnishings. In recent years, the "light decoration, heavy decoration" has tried to change the inherent design thinking mode, so that the soft furnishing design company has also gained more people's favor, unique design and soft furnishing

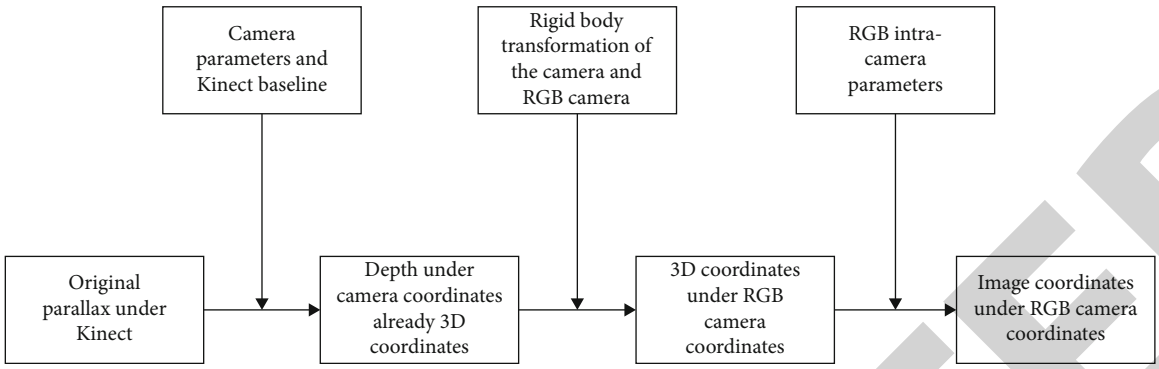

Figure 7: 3D coordinate model diagram.

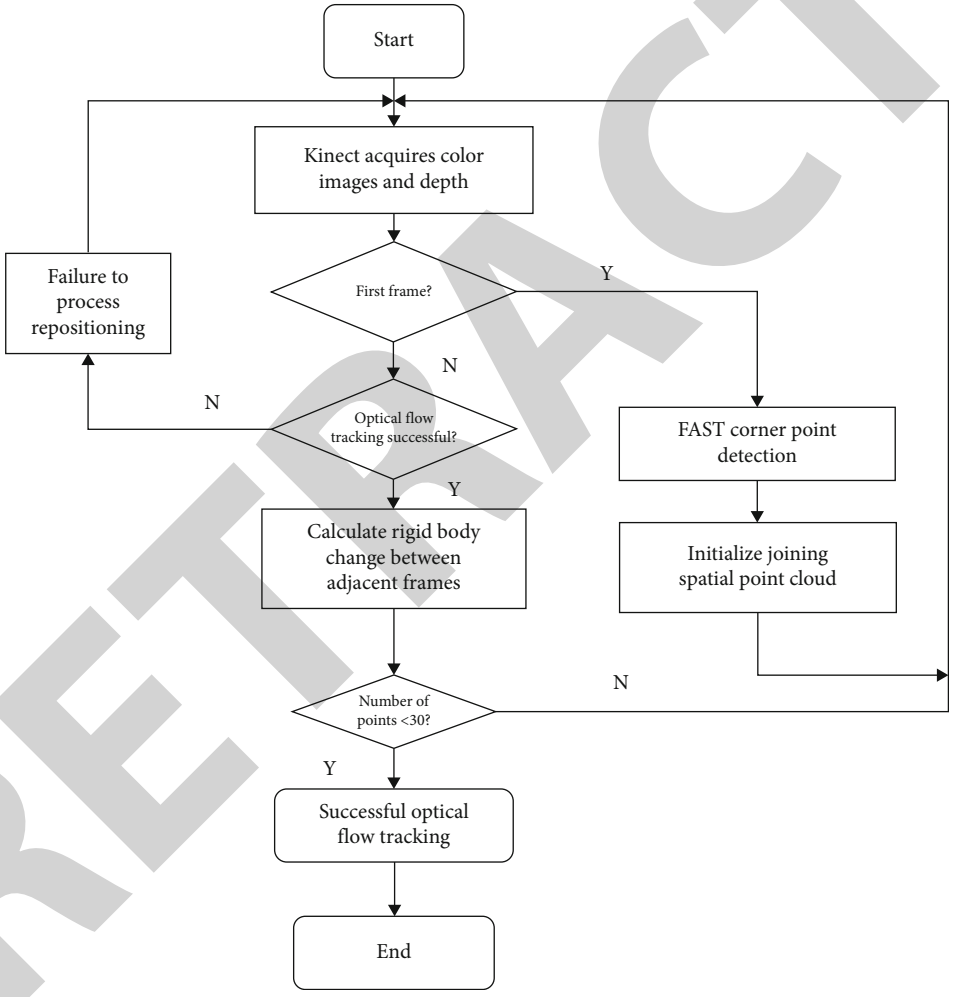

Figure 8: Accuracy analysis graph for different batch sample size.

design, to have an overall decoration of vibrant artistic mood. The extensive use of furniture, fabrics, furnishings, flowers, colors, etc., shortens the time distance between people. Comfortable office conditions will certainly lead to increased efficiency. The highest purpose of office space interior design is to provide people with a comfortable, square atmosphere, simple, healthy, safe, and fast office conditions in order to maximize their efficiency. The design model of office space is not always the same. Nowadays, office design is constantly data-informed, showing the trend of virtualization. Whether employees have a home office, cafeteria, garden, etc., the office can manage business work, and the office is most often used to provide a place for mutual communication and to create an office atmosphere. Therefore, the trend in office space design is to customize the space, and it is especially important to create an environment for communication and exchange in the space. However, due to the rise of Internet technology, people have become more dependent on the

Internet, neglecting face-to-face communication, which makes workers increasingly isolated and their social attributes weakened. Therefore, in the design of the new office space, care should be taken to avoid deepening conflicts, but to find a relative balance in order to obtain the best office space.

In order to facilitate the exchange of ideas, improve the level of democratic management of enterprises, many companies in China are often using public space and open office design. This space design gradually formed the new characteristics of the modern office and then produced a new theory of modern office space design. Office furniture is constantly updated to promote the continuous progress of modern soft furnishing design, and the modern aesthetic ability of modern people to enhance the requirements of another modern design field has achieved a higher level. In the fast-growing modern world, people need more design concepts, understand and accept more advanced design cases, extract experience and apply it to their own creative fields, and gradually understand the value of knowledge in the field of modern alternative design as they grow older. New materials and new techniques are the basis of modern soft furnishing design, the essence of modern alternative design, and one of the important ways to directly reflect modern taste and personality.

This paper mainly discusses the acquisition of visual signs in natural environment by SLAM technology, and through the more common Harris, SIFT, and FAST tilt measurement technology of Shanghai Huli Foundation for Historic Architecture and Urban Renewal, the real visible road signs in natural environment are acquired by using FAST tilt measurement according to the characteristics of natural environment instant 3D reconstruction technology, and the accumulated error set by SLAM algorithm and the depth map of the natural environment obtained by using the depth camera Kinect technology were carried out, and the basis of Kinect technology was introduced systematically, and the instant 3D spatial reconstruction architecture of the natural environment using Kinect technology and EKF-SLAM technology was established, thus completing the instant 3D reconstruction technology of the indoor and outdoor natural environment.

6.2. Summary of Experience. Soft furnishing design is a type of space design that includes not only fixed or immovable parts, but also the materials and furniture that can be easily replaced. Another type of space design includes furniture, windows and doors, lighting, plants, and handicrafts. These elements, through scientific combination and arrangement, will constitute a new kind of living space. The soft furnishing design can be in accordance with personal preferences and space characteristics to form their own new space. According to your own interests, living habits, and business conditions, you can develop your own design to highlight yourself, which is one of the effective ways to break through the conventional style. In space, it plays an important role in creating an environment, creating a mood, separating space, and strengthening the internal style. In order to facilitate the exchange of political ideas and strengthen social democratic activities, the government often implements public space and open space design to form a new feature of modern office, which also constitutes a new concept of modern office space. The continuous updating of office space design also promotes the continuous progress of soft furnishing space design, the improvement of people's aesthetic ability also makes another class of space development, and the improvement of people's aesthetic ability also makes the soft furnishing space design reach a more advanced level. In the new era of rapid development, people must constantly update their design concepts, understand and accept the most advanced design cases, and extract design experience in practice, while new materials and processes are the theoretical basis of soft decoration design, which is the core content of modern soft decoration design and is one of the important ways to directly reflect people's modern taste and reflect design style.

Data Availability

The dataset is available upon request.

Conflicts of Interest

The author declares no conflicts of interest.

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Retraction

Retracted: Two-Stage Research on AC/DC Hybrid High-Voltage Distribution Network Based on Network Reconfiguration and SOP Coordinated Control

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] X. Bai, Y. Zhang, C. Xu, Z. Zhao, and J. Wang, "Two-Stage Research on AC/DC Hybrid High-Voltage Distribution Network Based on Network Reconfiguration and SOP Coordinated Control," *Journal of Sensors*, vol. 2022, Article ID 2401475, 11 pages, 2022.

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Research Article

Two-Stage Research on AC/DC Hybrid High-Voltage Distribution Network Based on Network Reconfiguration and SOP Coordinated Control

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DC power grid has the advantages of large power supply capacity, easy access to clean energy, low loss, and easy power control. With the increasing penetration rate of distributed generation and DC load in low-voltage transmission network, the traditional radial AC distribution form develops into AC-DC hybrid form. Large-scale distributed energy access is an important feature of future distribution system. Aiming at the AC-DC hybrid distribution system with soft tie-in switch and voltage source converter, considering the network congestion caused by large-scale access of distributed energy, a two-stage congestion management mechanism is proposed. This strategy solves the congestion problem of AC/DC hybrid transmission network with the help of the power flow control ability of AC/DC transmission network's own optimization control means and congestion management services provided by distributed energy sources. According to the experiment, the total distributed generation power of DC link is 15 MW, and the load power is 10 MW, that is, the remaining power of DC link is 5 MW, the total distributed generation power of AC link is 8 MW, and the load power is 15 MW, that is, the power shortage of AC link is 7 MW. In the first stage, the tie-in switch, SOP and VSC are coordinated and optimized, and in the second stage, the flexible adjustment ability provided by distributed energy makes up for the deficiency of the adjustment ability of direct control means in some periods of severe congestion and meets the requirements of congestion management of AC-DC hybrid transmission network under high-permeability distributed generation.

1. Introduction

The high penetration and decentralized access of distributed renewable energy and the rapid increase of new loads such as electric vehicles will make the distribution system face strong uncertainty of source and load. Some urban transmission networks will be more prone to network security problems due to the limitation of line transmission capacity. The rapid growth of urban scale leads to the increasing power supply radius of urban transmission network, which makes the traditional power grid face the problems of increased line loss and voltage fluctuation [1]. At the same time, the increasingly tense corridors of power supply lines also put forward higher requirements for the transmission capacity of the lines [2]. In the traditional AC system, in order to limit the system within the safe boundary, the system operator must divert and select the optimal power supply path through the switching operations such as moving, replacing, and load shedding. However, a large number of standby lines are planned and built in the urban high-voltage transmission network, and there are many alternative paths for switching operations. Moreover, because the switching operations of regional dispatchers mostly focus on the local congestion that is occurring and cannot fully consider the optimal overall operation state, the switching operations are often frequent and large-scale, with many operations and high control costs.

With the increasing penetration rate of distributed generation and DC load in low-voltage transmission network, the traditional radial AC distribution mode has developed to the AC-DC hybrid mode [3]. AC-DC hybrid power distribution combines the advantages of DC power distribution

and AC power distribution and has obvious advantages in power supply efficiency, reliability, and flexibility. The randomness and volatility of distributed generation in AC/DC hybrid distribution system have a serious impact on the safe and stable operation of transmission network and power quality. Local transmission congestion is one of the most common security problems in the network. When the output of high-proportion connected renewable energy cannot be absorbed locally, a large amount of surplus power will flow to the remote load point through the power grid, making the transmission power of some transmission lines larger than their maximum transmission capacity, resulting in network congestion [4]. There are many kinds of equipment in AC/DC transmission network, and the grid-connected characteristics of different equipment are very different, which puts forward new requirements for the coordinated control of multiple converter stations in transmission network. The uncertainty of new energy sources and the difference of power flow calculation between AC and DC systems bring new challenges to the optimal operation and dispatch of AC and DC transmission networks [5, 6].

In order to better solve the congestion problem of transmission network, this paper proposes a two-stage congestion management mechanism based on SOP and VSC for AC/DC hybrid transmission network. This strategy solves the congestion problem of AC/DC hybrid transmission network by means of the power flow control ability of AC/DC transmission network's own optimized control means and congestion management services provided by distributed energy sources. In the first stage, considering the optimization and regulation ability of SOP, VSC, and tie-in switch which can directly control resources in AC/DC hybrid transmission network, a multiresource coordinated optimization scheduling model is established. In the second stage, considering the limitation of regulating ability of direct control resources, using flexible resources such as new energy power stations, electric vehicle charging stations, and adjustable loads, the congestion management control model is established with the lowest cost of distribution company as the optimization objective. Each grid-connected converter works in droop control mode according to the upper scheduling instruction, so that the system works in an optimized state when it is stable. When there is a bad working condition, the control strategy of switching the interconnected converter and the energy storage unit converter is adopted to maintain the DC voltage stability of the transmission network. In a long time scale, the corresponding optimization objectives are established for the normal operation of the system and the DC disconnection fault, and the scheduling instructions are provided for the lower layer through the optimized scheduling algorithm. The simulation results verify the effectiveness of the proposed control strategy.

1.1. Chapter Arrangement of This Paper. The first section of this paper introduces the extension research of AC/DC hybrid high-voltage transmission network by related scholars, the second section analyzes the topology of transmission network based on SOP, the third section makes experimental analysis on the effect of AC/DC hybrid high-voltage transmission network based on two-stage congestion management architecture, and the fourth section is the full-text summary.

1.2. The Innovation of This Paper. This paper proposes a two-stage congestion management mechanism for AC/DC hybrid distribution network with SOP and VSC, which makes full use of the power flow optimization ability of direct control means of distribution network and the flexible adjustment ability of distributed energy to effectively solve the network congestion problem.

2. Related Work

The main purpose of energy management of low-voltage AC-DC hybrid transmission network is to ensure the safe and stable operation of the transmission network, reduce the operation cost of the transmission network as much as possible, and improve the utilization rate of renewable energy. According to the grid structure of low-voltage AC-DC hybrid transmission network, it can be seen that energy management strategies include regional power distribution strategies and energy storage charging and discharging management strategies. In order to realize the energy management strategy, the real-time energy management system is also a very important part of energy management [7].

Khan et al. divided AC/DC hybrid transmission network into AC transmission network area and DC transmission network area and proposed a hierarchical distributed multi-source coordinated optimal scheduling system, including local scheduling layer and regional scheduling layer. The local scheduling layer only optimizes the interior of the region and then reports the optimization results to the regional scheduling layer. The regional scheduling layer coordinates the regional output from the global perspective [8]. Gao et al. put forward a flexible and reliable construction scheme of active transmission network. In this scheme, AC/DC hybrid connection, plug and play, high power quality construction, flexible DC loop closure, and other technologies are adopted to build a flexible and reliable active transmission network, and the comprehensive utilization of energy in Suzhou is realized through the coordinated optimal dispatch of source, load, and storage [9]. Li et al. proposed a flexible DC interconnection scheme for multimicrogrids and established an optimization model with the aim of minimizing the fluctuation of bus voltage in microgrids and the loss of the system. This method effectively suppresses the fluctuation of bus voltage and improves the permeability of renewable energy [10]. When Li and Zhang set up the optimization model, they considered the commutation loss caused by the power interaction between AC and DC, which improved the economy of the whole transmission network. From the previous literature, it can be seen that the load peak-valley difference among regions can be reduced by coordinating the distribution of power among regions. Reduce electric energy conversion links, reduce commutation losses, and improve the economy of transmission network operation. An adaptive control method with variable threshold is proposed, which uses adaptive intelligent

technology to control the charging and discharging power of stored energy, improves the distribution efficiency of electric energy, and realizes peak shifting and valley filling [11]. Fang et al. established the optimal dispatching model of AC/DC active transmission network based on the second-order cone programming. The model takes the minimum sum of power purchase cost and penalty cost of light and wind abandonment as the optimization objective and realizes the combined optimal dispatching of AC/DC active transmission network through measures such as active and reactive power regulation of distributed power, switching of capacitive reactance, charging and discharging of energy storage, reactive power regulation of voltage source converter, and dynamic reconfiguration of transmission network [12]. Ling et al. introduced the fuzzy stochastic optimization theory into the optimal operation of microgrid and solved the problem that the randomness and volatility of renewable energy have a great deviation to the daily dispatch [13]. Liu et al. proposed a two-stage real-time energy management strategy for the uncertainty of microgrid. First, the internal electricity price response mechanism was established according to the internal supply and demand relationship of microgrid, and with the minimum total cost of system operation as the optimization objective, real-time online dynamic optimization was completed based on MPC [14]. Dolatabadi et al. designed a microgrid energy management system based on ARM, including equipment layer, management layer, and optimization layer, which can realize local data monitoring and remote monitoring and scheduling. However, there is no research on real-time energy management strategy in this document, and the real-time performance of the system needs to be further verified [15]. Zhang et al. designed the hardware and software of the node controller for AC/DC hybrid microgrid. The hardware consists of ARM, DSP, and CPLD and provides multichannel digital input and output interfaces. The energy management system has rich hardware interfaces, fast data operation speed, and good anti-interference performance, which provides a hardware platform for the implementation of energy management strategies. However, the system cannot store a large amount of data, and it is very difficult to analyze the data in the later stage [16]. On the basis of studying the energy management strategy of energy storage system, Qu et al. put forward the mixed programming method of MAT and C#, which effectively combined the energy management strategy with the real-time energy management system, and provided the foundation for the implementation of the energy management strategy. However, this document only carried out simulation and did not carry out experimental verification in combination with the actual environment [17]. Wu et al. put forward an adaptive control method with variable threshold, which uses adaptive intelligent technology to control the charging and discharging power of stored energy, improves the distribution efficiency of electric energy, and realizes peak shifting and valley filling [18].

Because the congestion management of traditional AC high-voltage distribution network relies on traditional means such as switching power supply and switching power supply, and the scale is often huge, the improvement of model and algorithm cannot well meet the demand of rapid power adjustment caused by the strong fluctuation of distributed generation and the time-space transfer characteristics of new loads such as electric vehicles. Aiming at the above problems, this paper carries out congestion management based on network reconfiguration and SOP coordinated control technology.

3. Grid Structure Design of AC/DC Hybrid Transmission Network

3.1. Characteristics of Operation Form of High-Voltage Transmission Network Based on SOP. In the low-voltage AC-DC hybrid transmission network, because the power electronic devices are connected with the access of distributed power, the whole transmission network presents a high degree of power electronization, the loss of the converter becomes a nonnegligible part of energy management, and the control methods of the converter are flexible and diverse [19]. Traditional high-voltage transmission network generally refers to 110 kV transmission network, which consists of large-capacity transformers, long-distance transmission lines, capacitive cables, reactive power compensation devices, in-station circuit breakers and isolation breakers, and high-voltage buses for electric energy gathering and voltage monitoring. Some distributed power sources may be connected to the grid at this voltage level. Its topological structure is generally a multiring radial structure with extensive development, as shown in Figure 1.

Compared with the medium-voltage transmission network, its characteristics can be summarized as nondeep structure and abundant interstation communication: the nondeep structure means that the number of parallel load points along the line from the substation to a certain power supply terminal is small, which is because the load distribution of high-voltage transmission network is scattered and its capacity is large, and it is easier to cause the terminal voltage to be low when the deep network is adopted. There are abundant interstation connections, that is, there are many power supply paths or standby lines between 110 kV substation and other 110 kV substations and upper substations, and there are many combinations of main and standby power supply paths between stations. This is because the high-voltage distribution network is the connection link between the transmission network and the medium-voltage distribution network, which requires high reliability. This structural feature also makes the feasible solution space of the optimal model of reconstruction and supply transfer huge, and the optimal route of supply transfer is related to the wiring in the station and its operation mode, so it causes great difficulties to solve the optimal route.

Generally, a trunk road extending from one upper power supply node to another power supply node contains at most two or three 110 kV substations, which should be separated by circuit breakers to ensure that the electromagnetic loop of 220 kV-110 kV-220 kV cannot be formed, and each 110 kV substation has at least one or two backup lines connected to another 110 kV substation to ensure reliability.

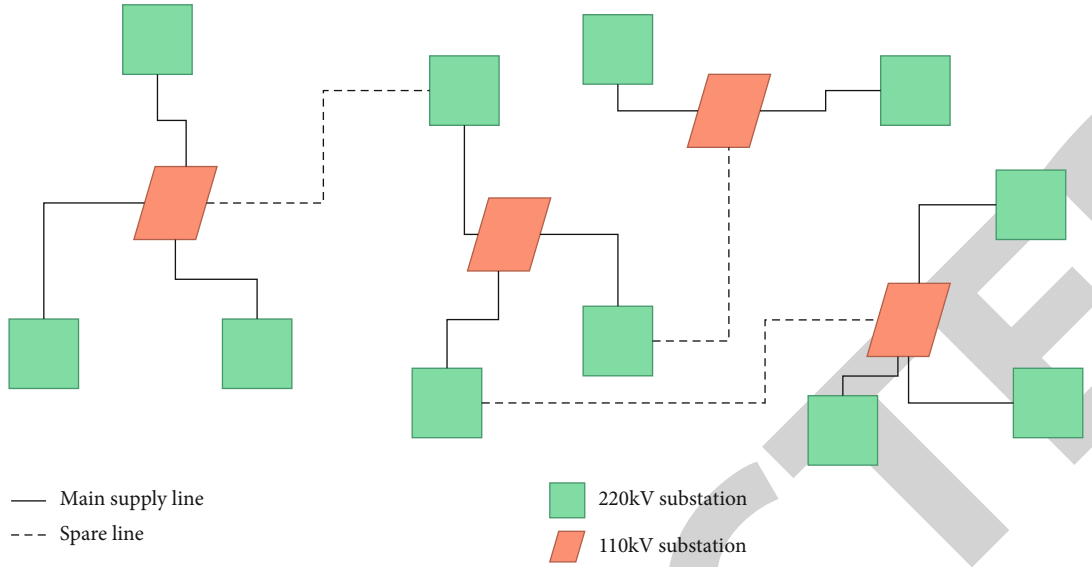

Figure 1: 110 kV topology diagram of 110 kV high voltage transmission network.

The equivalent treatment methods under different control modes of VSC are shown in Table 1.

In chain transmission network, each load can only get electric energy through a single path. Chain DC transmission network has simple structure and low requirements for protection system and simple operation. However, in the chain transmission network, if the medium voltage bus or AC/DC converter fails, all the load power supply in the transmission network will be affected, and even a large area of power failure will occur [20]. Therefore, the power supply reliability of chain structure is low. In AC/DC hybrid transmission network, VSC converter station plays the role of AC/DC subnetwork energy exchange and maintaining system voltage stability, and the coordinated control strategy among multiple converter stations is the premise of safe and efficient operation of the whole system. The coordinated control strategies of multiconverter stations mainly include master-slave control, DC voltage deviation control, and sag control.

All new loads and distributed power sources are connected to AC lines, among which new DC loads and photovoltaic cells need to be connected to the inverter through DC transformers, wind turbines need rectifiers and inverters to be connected to the grid, and new AC loads need to be connected to the grid through AC transformers. If the interconnected converter is controlled by constant active power, the optimization variable is the input and output power reference value of the interconnected converter. If that DC bus voltage is control, the optimization variable is the reference value of the corresponding DC bus voltage. In case of DC voltage droop control, the optimization variable can choose the input and output power reference value of interconnected converter or the corresponding DC bus voltage reference value. The principle of master-slave control in normal operation is shown in Figure 2.

In the figure, the dashed boxes indicate the operating range of the converter station, and the solid dots are the current operating points. The master-slave controller will take one converter station in the transmission network as the master converter station and other converter stations as the slave converter stations. The main converter station is controlled by constant DC voltage, which controls the DC voltage output by its port to maintain the stability of the whole subnet bus voltage. The slave converter station adopts constant active power control. Data exchange is realized between the converter stations through the communication system. When the main converter station fails, a group of slave converter stations will receive more information instructions and switch to constant DC voltage control. All converter stations in the transmission network have equal status, adopt the same control mode, and share the DC voltage offset of the system.

Ring distribution network connects the distribution network into a ring network based on the two-end power supply structure. When any line fails, the connected bus can rely on the power supply of other lines to ensure the normal operation of the connected load, so it has the highest power supply reliability. Considering the congestion management mechanism of AC/DC hybrid transmission network based on SOP and VSC, there are two stages. In the first stage, the congestion problem is solved at a lower cost by directly controlling the adjustment ability of resources. In this stage, distributed flexible resources operate according to their own power generation plans or electricity demand, which avoids the impact of congestion on users and improves the service quality of the system. In the second stage, when the line congestion is serious, it is not enough to completely solve the congestion by directly controlling the resources through the transmission network. At this time, it is considered to mobilize distributed flexible resources to participate in congestion management, send regulation signals to each distributed energy source, and each distributed energy source responds to the regulation signals and uploads its congestion management quotation to the transmission network

Table 1: Equivalent treatment of different control modes of VSC.

Active power control method	Reactive power control method	Ac equivalent node	Side DC equivalent node
Constant active power control	Constant reactive power control	QP node	U node
Constant DC voltage control	Constant reactive power control	OS node	P node
DC voltage droop control	Constant reactive power control	PA node	P node

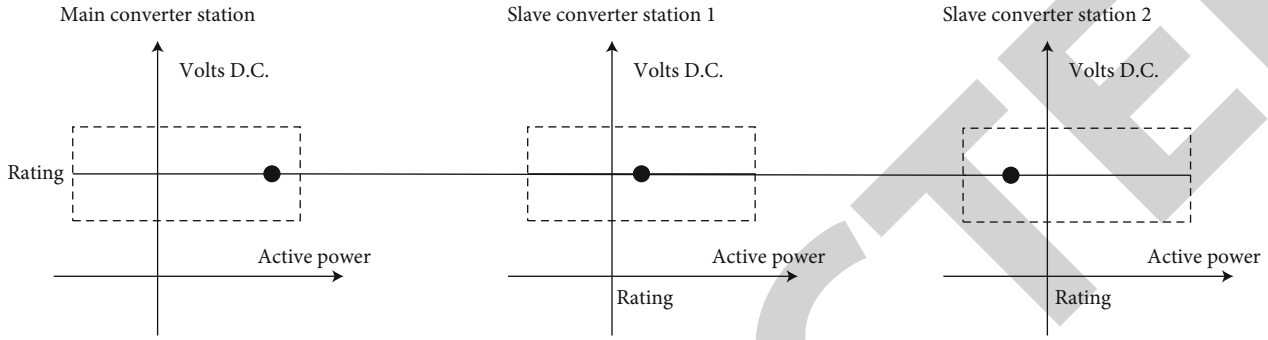

Figure 2: Operation principle of master-slave control.

management center. Based on the quotation, the transmission network management center establishes a congestion management control model with minimum cost and sends regulation instructions to each distributed flexible resource. The corresponding parameters and initial iteration values of each DC node are shown in Table 2.

When any group of converter stations fails, other converter stations will adjust their output power according to the drop value of DC bus voltage and their respective droop characteristic curves, thus making up the power shortage of the system and maintaining the stability of the system voltage. The optimization model of joint operation control based on SOP is to ease the power flow congestion of overload lines by coordinating the reconfiguration of the lower high-voltage transmission network with SOP transmission power control and at the same time achieve the goal of minimizing the overall control cost of operation. The objective function of congestion management during peak load is shown in the following equation.

$$f = \min \sum_{i \in N} d_i \Delta P_i^C + \sum c \Delta p_i. \tag{1}$$

The active power and reactive power balance constraints of high-voltage transmission network are shown in the following formulas.

$$p_i - \Delta q_i = \sum_{j \in N(i)} \left(p - I_{ij} r_{ij}\right) - \sum_{k \in N(d)} \left(p - I_{ik} r_{ik}\right), \tag{2}$$

$$q_i - \Delta p_i = \sum_{j \in N(i)} \left(q - I_{ij} r_{ij}\right) - \sum_{k \in N(d)} \left(q - I_{ik} r_{ik}\right). \tag{3}$$

According to the radial operation constraint, the necessary condition of radial operation of transmission network is that each loop should be disconnected with one branch. The premise of this necessary condition is that any load can only get electric energy from one power source through the line. For the convenience of calculation, the distributed power source can be regarded as the negative load at this node, not the power source point. The node matrix is shown in the following formula.

$$\begin{bmatrix} 3 & 1 & P_{L1} & Q_{L1} \\ 4 & 4 & Q_{L2} & P_{L3} \end{bmatrix}. \tag{4}$$

In order to keep the radial network structure, the transmission network is generally designed in closed loop and operated in open loop. Closed-loop structure is to facilitate power supply transfer in case of failure and improve the reliability of power supply in operation. Open-loop operation can effectively limit the short-circuit fault current, protect the devices on the line, and prevent the circuit breaker from exploding. On the other hand, it is to control the fault spread and prevent a large-scale power outage.

In the first-stage optimal scheduling model, SDPT3 solver is used to solve the subproblem SDP model without discrete variables, while CPLEX solver is used to solve the nonlinear integer programming main problem model. After solving, the hourly total system loss, internal loss of all converter stations, and AC side output of each converter station are obtained. As a DC power supply to supply power to the DC link. All loads, distributed power sources, and energy storage devices are connected to the corresponding buses according to the principle of less commutation process, that is, the original AC loads and newly added AC loads are connected to the AC unit through AC transformers, and the DC loads and low-voltage loads of the original AC lines can also be connected to the DC buses according to the actual situation. The AC smoothing equation is shown in the following formula.

$$P_{t1} + P_{t2} = p_{\text{loss},ac} + p_{\text{load},ac} + p_{va} + p_{v2}. \tag{5}$$

Table 2: Variables corresponding to DC node types and initial iteration values.

Node type	Variable corresponding to node type	DC node actual distribution active power	Sagging coefficient
P node	0	Psec	Uxdp
Q node	3	Pxdp	1.0pu
P-Q node	1	-Pk	1.0pu

When any line in an AC unit fails, within the power supply capacity of DC link, DC link can supply power to the load in the nonfault section of the line through the corresponding VSC. Because VSC can isolate AC/DC faults, the normal operation of another normal AC line and DC link will not be affected by the fault.

3.2. Topology Analysis of Transmission Network. First, this paper gives the mathematical model of transmission network reconfiguration, including the objective function of reconfiguration and various constraints. The new data storage structure of transmission network is adopted, which is convenient to solve the reconfiguration problem. Loop division is selected to improve the coding mode, and the method of identifying infeasible solutions is given. At the same time, the greedy strategy is introduced, the cuckoo algorithm is improved by adopting adaptive step size and discovery probability, and the application flow of the algorithm for network reconfiguration is given. Finally, the improved cuckoo algorithm is applied to two transmission network examples, and the feasibility, efficiency, and accuracy of the algorithm are verified.

The installation of SOP basically does not change the original topology, and only the cause contact switch can be replaced. However, since SOP can control the transmission power of the line where it is located, the adjustment path of back-to-back VSC can be dynamically established by reconfiguring the switches of high-voltage transmission network to control the injection or outflow of active power and reactive power. In order to verify the effectiveness of the algorithm for transmission network reconfiguration, an example of IEEE33-bus distribution system is analyzed in this paper. The topology of the distribution system includes 38 nodes and 42 branches, including 2 power nodes and 6 connecting branches. The reference power is 100MVA, the rated voltage is 12.66 kV, the active load of the nodes is 3824 kW, and the reactive load is 2170kVar. Programming in Matlab R2013a environment can get the reconstruction results as shown in Figure 3.

The main purpose of the lower optimization model is to distribute the power among different areas in a coordinated way. By controlling the transmission power of interconnected converters, the bus voltage connected to interconnected converters, and selecting the reference point for secondary regulation of interconnected converters, the fluctuation of distributed generation has the smallest impact on the transmission network. Distributed generation is an important part of AC/DC transmission network. This paper introduces the characteristics of common wind turbines in distributed generation. Considering the uncertainty of wind speed in nature, in order to use wind energy safely and effectively, fans are generally equipped with gearboxes, monitoring, and protection. There are many random variables in the optimization algorithm, which leads to strong uncertainty in every execution of the algorithm. It is difficult to explain the advantages and disadvantages of the algorithm only by running a program once. In order to verify the efficiency of this algorithm, it is compared with the single cuckoo algorithm and the traditional particle swarm optimization algorithm. The three algorithms are run 30 times each, and the convergence curves of PSO, CS, and improved CS algorithms are drawn by taking the average of the reconstructed results, as shown in Figure 4.

There are many random variables in the optimization algorithm, which leads to strong uncertainty in every execution of the algorithm. It is difficult to explain the advantages and disadvantages of the algorithm only by running a program once. The improved algorithm proposed in this paper has strong searching ability, which can quickly find the vicinity of the optimal solution in the early stage of iteration and converge to the optimal solution stably in the middle and late stage of iteration. It can not only solve the reconfiguration problem of different transmission networks but also maintain high efficiency and accuracy in the process of solving. If a line contains a DC/DC converter, the line voltage will also change with the change of the converter control mode. In this case, the DC/DC converter can be added to the power flow calculation in a way equivalent to the series resistance of an ideal transformer, and the correction equation is shown in the following equation.

$$\begin{bmatrix} \Delta p_1 \\ \cdots \\ \Delta p_m \end{bmatrix} = P \begin{bmatrix} \Delta U_1 \\ \cdots \\ \Delta U_m \end{bmatrix}. \tag{6}$$

The voltage adjustment value is obtained according to different iteration correction times, as shown in the following equation.

$$P = \begin{bmatrix} \dfrac{\partial \Delta p_1}{\partial U_1} & \cdots & \dfrac{\partial \Delta p_1}{\partial U_m} \\ \cdots & \cdots & \cdots \\ \dfrac{\partial \Delta p_m}{\partial U_1} & \cdots & \dfrac{\partial \Delta p_m}{\partial U_m} \end{bmatrix}. \tag{7}$$

In AC/DC hybrid transmission network, the characteristics of DC system without inductive reactance and capacitive reactance make voltage the only index to measure the power balance of DC network. Converter station level control plays a vital role in maintaining DC power balance

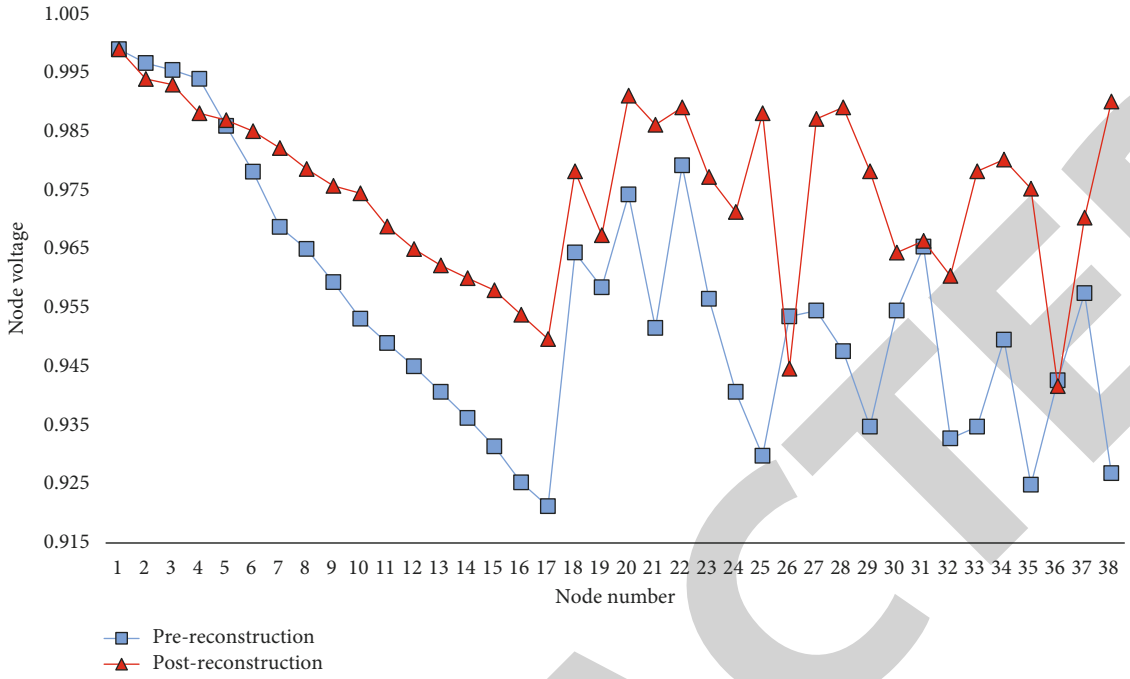

Figure 3: Distribution of node voltage before and after reconfiguration of IEEE 33-node distribution system.

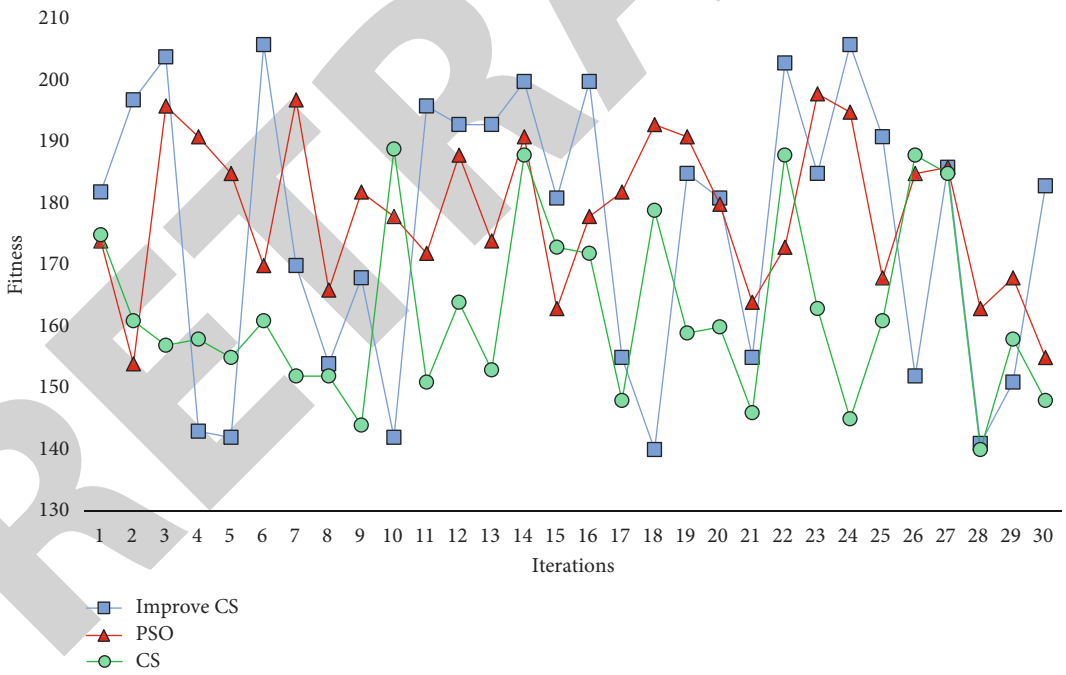

Figure 4: Convergence curve of algorithm.

and voltage stability. Master-slave control means that the main converter station adopts constant DC voltage control to ensure the power stability of the whole DC system, and the rest converter stations adopt constant power control. This method requires high communication between stations, and once the main converter station fails, the system will face the danger of collapse. Voltage margin control can be regarded as the improvement of master-slave control. This method does not rely on interstation communication and has strong regulating ability, but it has DC voltage deviation. Alternating iteration method takes coupling variables as the global iteration object to calculate the power flow of AC system and DC system, respectively, so this method has strong applicability for AC/DC distribution systems with different port numbers.

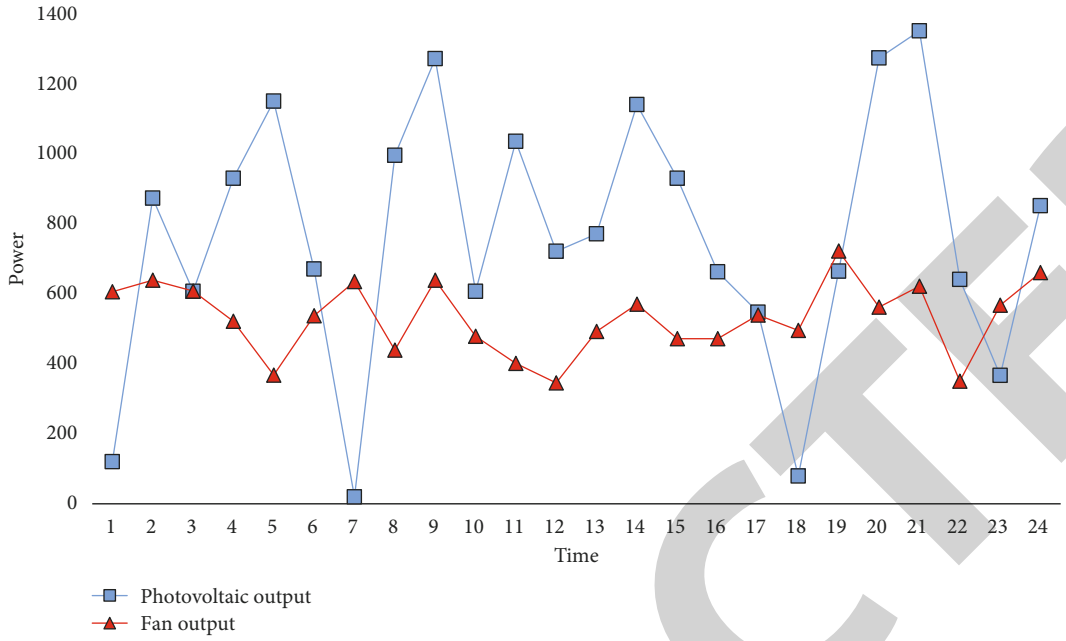

Figure 5: Output size of distributed power supply.

4. Two-Stage Congestion Management Architecture of AC/DC Hybrid Transmission Network

4.1. Two-Stage Congestion Management Architecture. The adjustable resources in AC/DC hybrid transmission network include the resources that can be directly controlled by distribution companies such as contact switch, SOP, and VSC, as well as distributed flexible resources such as new energy power stations, electric vehicle charging stations, and adjustable load aggregators. Among these two kinds of resources, the first kind of resources is called direct control resources, which belong to power grid assets, and the regulation cost of these resources is very low. Constraints include system power flow balance constraint and system operation constraint, in which system power flow balance constraint includes AC power balance constraint and DC power balance constraint, and system operation constraint includes node voltage constraint, AC line power flow constraint, DC line power flow constraint, network topology constraint, and SOP and VSC operation constraint.

In the congestion management of transmission network, direct control resources are the priority of regulation resources. Distributed flexible resources, such as new energy power stations and electric vehicle charging stations, generally operate according to their output plans or charging requirements, and it takes a high cost to regulate them. Therefore, they are used as the second-stage candidate regulation scheme when the priority regulation resources cannot eliminate the network congestion. DC line is transformed from AC line, and AC line and DC line are connected by VSC. In order to fully consider the impact of distributed power generation, three wind turbines with a capacity of 350 kW and four photovoltaic power generation systems with a capacity of 360 kW are added in the example, with power factors of 0.8. The daily load and distributed power output are shown in Figure 5.

Network reconfiguration reduces the loss by changing the topology of the system, and its loss reduction ability is limited. SOP and VSC can realize the precise control of the active power transmission between lines and provide certain voltage and reactive power support, thus realizing the economical and efficient operation of the system. Due to the strong randomness and volatility of distributed generation's output, its first-stage output forecasting accuracy is low, so it is necessary to revise the current dispatching plan in a short time according to the ultrashort-term forecasting information, so as to ensure the safe operation of the distribution network.

4.2. Analysis of Optimization Effect. The optimal dispatching model of AC/DC hybrid transmission network optimizes VSC and SOP of tie switches at the same time. The optimized variables include both discrete variables and continuous variables. This paper adopts the mixed integer second-order cone programming method to solve it. In the second stage, the congestion management control model is solved by the second-order cone programming method. After the second-order cone transformation of the model, it is directly solved by using mature commercial software. The proposed mathematical model is programmed by MATLAB, and different results are compared by different optimization schemes, as shown in Figure 6.

It can be seen from the figure that using the diversity of high-voltage transmission network operation modes to dynamically construct SOP connection path greatly improves SOP power flow regulation ability and effectively alleviates congestion. The simulation results show that the proposed

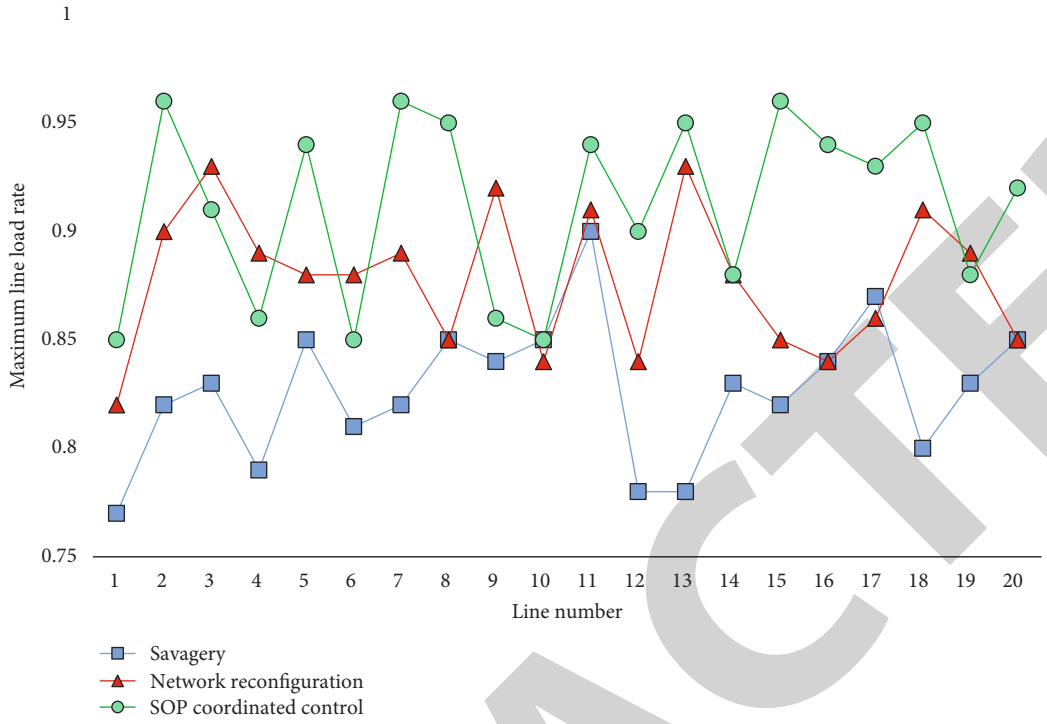

Figure 6: Comparison of load rates of different line operation schemes.

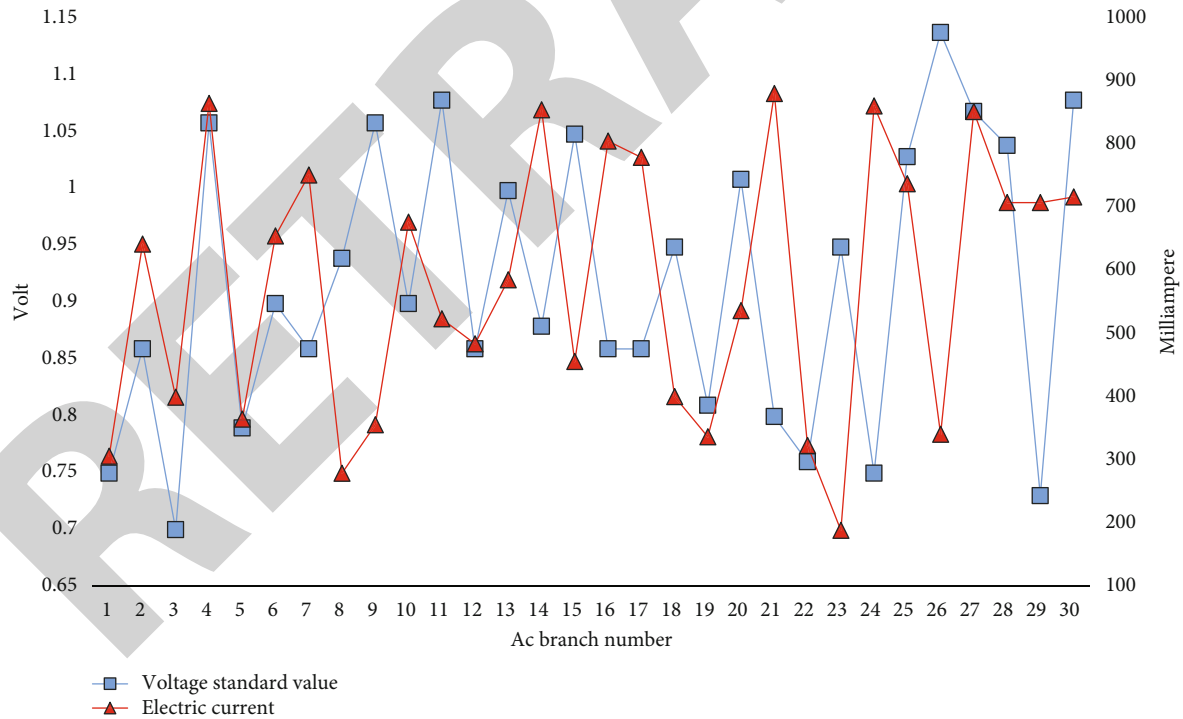

Figure 7: Current of each branch after reactive power compensation.

method can effectively reduce the maximum line load rate and node load rate, make the power flow distribution more balanced, leave enough margin in each part of the network, and improve the security level of the system operation. High-voltage transmission network reconfiguration is a coarse-grained discrete power flow transfer strategy, which is difficult to meet different local network constraints at the same time, resulting in unnecessary load shedding. However, with the fine-grained control capability of SOP's continuous refinement, it can make up for the error caused by discrete supply transfer, effectively reduce the load loss, and greatly reduce the control cost, as shown in Figure 7.

In the first stage, the coordination and optimization of tie-in switch, SOP, and VSC effectively enhanced the absorptive capacity of transmission network for renewable energy, reduced the impact on users' electricity consumption, and reduced the congestion management adjustment cost. In the second stage, the flexible adjustment ability provided by distributed energy makes up for the deficiency of adjustment ability of direct control means in some severe congestion periods, reduces the risk of line power flow exceeding the limit, and meets the requirements of congestion management of AC/DC hybrid transmission network under high permeability distributed power. The total distributed generation power of DC link is 15 MW, and the load power is 10 MW, that is, the remaining power of DC link is 5 MW, the total distributed generation power of AC link is 8 MW, and the load power is 15 MW, that is, the power shortage of AC link is 7 MW. In practice, when the load is heavy and the line is long, the voltage of all nodes may not be adjusted to the normal level only by reactive power compensation at the end of the line. At this time, it is necessary to take additional appropriate reactive power compensation measures at the nodes with too low voltage. The analysis shows that after the transformation of AC-DC hybrid transmission network, providing certain reactive power compensation to AC lines through VSC can effectively reduce the input of reactive power compensation equipment and improve the power supply quality of AC lines.

5. Conclusions

In order to describe the loss characteristics of the converter more accurately, based on the steady-state model of the converter, the loss model of VSC is approximately represented by nonlinear function, and the loss model of DC/DC converter is approximately represented by equivalent resistance. By analyzing the control characteristics and external characteristics of the converter, the equivalent treatment methods of different control modes in energy management are given. The structure of AC-DC hybrid transmission network proposed in this paper is theoretically correct and feasible. The DC link can not only ensure the DC load and the grid connection of distributed power but also provide appropriate reactive power compensation to AC lines, thus improving the supply voltage and quality of AC lines. The reconfiguration of high-voltage transmission network is a coarse-grained discrete power flow transfer strategy, which is difficult to meet different local network constraints at the same time, resulting in unnecessary load shedding. However, with the fine-grained control capability of SOP's continuous refinement, it can make up for the error caused by discrete supply transfer, effectively reduce the load loss, and greatly reduce the control cost. In the positive sequence component control system, generally speaking, the limiting link is included in the outer loop power controller, and the current limiting control is realized by giving a current command, which effectively avoids the overcurrent problem of VSC.

In this paper, when optimizing the operation of AC/DC system, only a single-objective optimization model is established, and many indicators such as wind abandonment rate, new energy subsidy, and equipment depreciation cost need to be considered in actual dispatching. Based on this, the next work can establish a multiobjective optimization model of AC/DC distribution network.

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Retraction

Retracted: Industrial Information Security Detection and Protection: Monitoring and Warning Platform Architecture Design and Cryptographic Antitheft Technology System Upgrade

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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Research Article

Industrial Information Security Detection and Protection: Monitoring and Warning Platform Architecture Design and Cryptographic Antitheft Technology System Upgrade

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Industrial information security is an important part of the national security strategy that affects the economy and people's lives. With the rapid development of automation and information technology, common protocols and common hardware and software based on information technology are increasingly used in industrial information control system products and are widely used in industries such as energy, metallurgy, water resource management, chemical, and production. Attacks on critical industrial information can not only cause accidents, losses, and local production pollution but also disrupt the balance of supply and demand of raw materials in the area covered by the system. Therefore, it is of great theoretical and practical importance to study industrial information security as an important measure to ensure the stable operation of the system. In this paper, we analyze the main industrial structure characteristics, external environment, and security requirements and propose a monitoring and warning platform architecture with cryptographic antitheft technology system based on hierarchical modeling and closed-loop control. It can prevent the spread of the attack and reduce its negative impact.

1. Introduction

With the rapid development of automation and information technology, common protocols and common hardware and software based on information technology are increasingly used in industrial information control system products and are widely used in industries such as energy, metallurgy, water resource management, chemical, and production. Meanwhile, in order to meet the data sharing needs of existing industrial management networks and improve production and operation efficiency, industrial management systems of remote physical facilities can be widely connected to the Internet or other public networks. With the development of information technology, threats such as viruses and Trojan horses are also spreading in the environment of industrial control [1]. The information security of industrial information control systems is getting more and more attention in the face of severe threats in the field of information technology applications due to the product characteristics and the network connection of industrial information control systems. Industrial information control systems are widely used in industries such as energy, water supply, energy, and transportation. These areas are important cornerstones for the development of our information infrastructure, and their security and social development are inseparable from the security of the general public. In recent years, industrial information control systems have been subject to frequent and serious security incidents. The security of industrial information control systems is a worldwide concern, and Chinese industrial enterprises are facing these serious security challenges. In China, many companies engaged in industrial controls have also experienced information security incidents such as virus infections and malicious attacks targeting transportation networks, chemical, power, oil, and other industries that are relatively dangerous and vulnerable to social unrest. These attacks can have a serious impact on production, weaken industrial information control systems, and cause incalculable economic losses or endanger people's lives, causing various production accidents and affecting the overall stability of society. The

information security risks in China's industrial information control system have the following characteristics: first, the current industrial information control system in general lacks good security functions. China faces limitations in industrial control and information security for several reasons: the equipment and hardware widely used by industrial companies are mainly imported from developed countries such as Japan and Germany, and their security itself is unknown. Due to the borrowing of foreign products, its security is somewhat difficult; China's industrial companies in general have information security problems, security technology lags behind, and the gap between security management and foreign countries is large. Industrial control system even has some general shortcomings, and repair requires a lot of human and material resources. Second, there are more and more attacks on industrial control networks [2]. Stuxnet is a very representative term in industrial history. It was the first virus that deliberately attacked industrial information networks. The impact of super viruses has brought real attention to the security of industrial information control systems. In recent years, with the rapid development of the Internet, cyberattacks on industrial information control systems have become more and more frequent, and the means to do so have become more and more frequent. These viruses can easily affect the entire industrial information control system, from production damage to serious security incidents to social instability. Third, industrial information control systems are often threatened by internal and external diversification. Today, it is typical for industrial information management systems to be hacked, and hacking attacks have the following characteristics: social influence, purpose, clarity, and destructive power. Most threats are caused by external natural factors such as cyber warfare between countries, attacks, hackers and other criminals, network attacks, and system disruptions. The problem of information security of industrial information control systems can hardly be solved by modernization. The main purpose of security protection of industrial information control systems is to ensure the stability and productivity of industrial production. On this basis, we must rely on core networks, industrial control networks, etc., and take some security measures. In addition, there are differences between traditional information systems and new industrial information control systems in terms of resource limits, operating systems, etc. In short, in terms of industrial security and security control, we must combine our own characteristics and the unique security requirements of different industries. We will gradually explore industrial information control systems with different security measures and solutions and gradually improve the comprehensive strength of information security of our industrial enterprises [3].

As industry plays a pivotal role in China's national economy and people's livelihood and China's industrial information security has unavoidable risk factors and faces great risk challenges, so in order to prevent industrial information leakage and risk events such as hacker attacks, this paper designs a monitoring and warning platform with password antitheft technology, hoping to prevent criminals to a certain extent in the industrial information control system This paper designs a monitoring and warning platform and password theft prevention technology, hoping to prevent criminals from invading industrial enterprises after causing damage to industrial information control systems to a certain extent, so as to develop scientific and effective security policies.

2. Research Background

According to the industrial information system security reports in recent years, the number of industrial information leakage is increasing year by year. Security incidents of industrial control information systems are becoming more and more serious and frequent in areas such as power supply, basic production, and public transportation. Through the analysis of industrial information security incidents in recent years, it is concluded that industrial information control system attacks have new features with previous industrial control network attacks [4]. They directly damage hardware resources, use computer Internet viruses or industrial information management systems against viruses to connect and disconnect devices. In addition, due to the technology associated with the Internet in recent years through the Internet into the work monitoring network, Trojan horse virus has become a new means of attack. The economic losses caused by industrial information security incidents are increasingly serious, and their additional negative impact is incalculable. The most representative industrial information security breaches in recent years include the attack on the industrial control components of the Bushehr power plant and the major damage to the national nuclear power plant [5]. In 2011, hackers penetrated the operation management system of the Shinkansen. In 2015, Baku Energy Company received constant high-level threats due to the ongoing attacks on the power supply in several regions of Ukraine, which led to total blackouts; on October 21, 2016, hacker groups used the Internet and hacked webcams that provided domain analysis services to a number of U.S. companies. This information attack included tens of millions of IP addresses, and over 1 million devices connected to the network were compromised. Asif et al. propose a data collection method for assessing the state of network security using MEDA. First, the system is used to collect a large amount of network attack data, then the alarm information is classified, correlations between the data are analyzed, and system state mapping is completed. This method can summarize the current intrusion information of the defense system and draw the corresponding state diagram, but the process data only comes from the network intrusion information, and the data sources are relatively independent. It is difficult to make a complete and accurate description of the overall security situation of the network because many other elements are missing [6]. Yongho and Boyoung proposed a network security status assessment method based on a data storage security incident database system. The method not only captures system alarm logs but also analyzes other security data to ensure that all data are securely connected. Alarm log correlation analysis allows independent detection of new security events. However, the security coefficients

considered in the method are not comprehensive, and there is no specific quantitative analysis, so accurate results cannot be obtained [7]. Kota et al. proposed an integrated state analysis combining modeling; aggregation and game theory improves the prediction efficiency but is very demanding on the network attack and defense model. There are too many factors to be considered to design more complex models. To address these problems, Yuan and Iftekhar improved the adaptability of this approach and developed attack models and analyzed possible variations using a Bayesian network approach, but this approach still requires preparation to obtain the appropriate parameters, and the labeled data must be retrieved for ranking [8]. In China, Chen et al. proposed a quantitative cybersecurity assessment model based on data from multiple sources. Considering the impact of host and network on network security, the network security index is divided into host security index and channel security index. The test data such as records and alerts in summary logs are summarized using the improved D-S evidence theory to obtain a simplified set of host security events and related security events. Based on the information of related services, the node security status and connection security are calculated, and the network security status is quantitatively evaluated. A network security evaluation model based on traffic estimation is proposed. The integration of services, hosts, and information systems is of importance in a network based on signals and information flow from intrusion prevention systems, bottom-up, and local-to-whole network system security model. The degree of damage of different types of network threats is determined based on the degree of degradation of connectivity performance to secure information systems. Niraj et al. introduced a state estimation model based on empty network information and real network parameters. The model first collects system hacker information into the network, analyzes host room information, and then connects it to the threat index of nodes. Feedback is given to change the threat index based on the actual index parameter information collected by the system. Finally, network device parameter information, host protocol and system characteristics, calculated system security state information, and security state analysis results are used. The prediction of the future state of the system is given. The model is effective in the estimation and prediction of network errors, but the range of selected indicators is not wide enough; there is a lack of clear connection between them, the algorithm is not widely applied, and the prediction accuracy needs to be improved [9]. A comparison of the current status of domestic and foreign research shows that foreign researchers tend to develop specific system models for specific scenarios, which are then used to evaluate or predict the target scenario. This approach works well for a given target situation, but each model has high specificity for a given situation and does not have sufficiently broad coverage and reliability. In contrast to dynamic prediction, sufficient domestic research has been conducted to propose various state estimation methods, which have some practical value in some aspects. However, in general, the selection of dynamic indicators and the combination of weighted data in the process of condition evaluation are highly subjective and random. However, there are no formally agreed evaluation criteria for the results of condition evaluation, which makes it difficult to quantify specific methods and is not conducive to comparative analysis of different scenarios. In contrast to condition evaluation, the unexpectedness and uncertainty of network operation complicate the situation. Most of the current research is theoretical, and in practical applications, many optimized machine learning algorithms are commonly used to build prediction models for network security situations, but most of them have accuracy problems and require some measures to optimize the prediction accuracy [10].

In summary, for the seriousness of industrial information leakage, domestic experts have made very adequate examination and prediction and designed relevant system prediction models to circumvent the situation of network and other hacker invasion of industrial information management system; this article is based on this theory to develop the design of detection architecture and antitheft system upgrade design.

3. Research Methods and Materials

3.1. Analysis of System Design Elements

3.1.1. The Security Needs of Industrial Information Systems. Due to the continuity of industrial production, industrial information control systems have very strict requirements for standardization and rapid response from operators. In case of emergency, specific measures must be taken, and replacement plans must be made quickly to ensure the continuity of production. Industrial information control systems have tightly controlled access to the system, and unauthorized persons are not free to access the system and usually have only limited access to the system. Industrial information control systems should regularly test the existing security facilities to ensure that they are functioning properly at all times and in all environments to cope with the needs of industrial production. Information security process control requirements are relatively lenient, and IT security systems are relatively developed, although many improvements are needed, such as intrusion prevention systems, logging, and security checks [11].

3.1.2. Security Threats to Industrial Information Systems. Security threats to industrial information control systems generally come from software systems, such as industrial information control software and special industrial control protocols. In the early stages of development, most of these systems and protocols are in closed environments where information security considerations are often inadequate. For example, the problem of poor industrial technology design of platform architecture. These components are usually more vulnerable and relatively susceptible to external attacks, such as the Modbus TCP protocol, which was not considered for security in the early stages of development. In industrial information control systems, communication includes both periodic and acyclic communication modes, but the amount of information transmitted during

communication is small and the demand for network flows is not high. The entire management and control process of the system is usually determined at the first configuration [12].

3.1.3. Objectives of the System Design. From the point of view of the three information security elements—confidentiality, integrity, and potential—the main objective of the industrial information control system is to ensure the smooth operation and production of industry. Therefore, the main objective of the industrial information control system is capability. The main task is to ensure the availability of information from industrial facilities and the proper functioning of the system. Secondly, since industrial production requires production processes and control accuracy, information integrity is critical to industrial information control systems. Because there are relatively few requirements for information integrity and accessibility, confidentiality, integrity, and availability of the three elements of information security in information systems are critical [13], as shown in Figure 1.

3.1.4. Implementation of Protection Functions. Protection functions can be divided into two levels, from low to high, i.e., other matters in terms of data protection industrial information control system to ensure the security of data during the operation of the power plant, including the state and operating process parameters; the system pays more attention to the security of data storage [14]. The process of storing data on the server requires more, and data protection measures are more stringent. Although industrial information control systems place higher demands on the timeliness, security, and reliability of communications, they tend to be oriented toward routine communications in networks, i.e., in networks. Network security systems are mainly concerned with technical security and product security. To ensure the security of the system, industrial control focuses more on the security of access to devices, especially the communication between devices and unauthorized access to devices, while industrial information control systems are more concerned about the vulnerability of computers and other operating systems and unauthorized access to resources, as shown in Figure 2.

3.2. Forms of Information Security Intrusion

(1) Although industrial firewalls are usually located between corporate office networks and industrial information management systems, violators can penetrate through firewalls by means of bouncing, mediation, spoofing, and eventually accessing industrial information management systems [15]

(2) Wireless transmission technology is usually widely used to access industrial information control systems in wireless communication networks, with the central control node acting as a repeater to provide remote communication between multiple device nodes. The openness of wireless network access also contributes to the increase in intrusion and information theft [16]

(3) Some industrial control equipment manufacturers require remote connections to install, maintain, and update equipment. They can access industrial information control systems through remote PCs using modem dial-up networks, and intruders can use weak passwords and other vulnerabilities to gain access to industrial information control systems. It is also possible to access the industrial information control system indirectly by hacking into the remote host [17]

(4) "Reliable" connection to the user to create a "trusted channel" to access remote service support provided by the control system vendor or third party. The trusted channel may not follow the appropriate security policy or the third party may lack the necessary security policy, leading to external intrusion [18]

(5) Remote end-unit access means are used in public places, usually unattended, and can be easily detected and exploited by intruders as a direct path to the site of damage [19]

(6) Other public communication facility system connection as part of the industrial control communication system. In addition, due to the high cost of network construction, higher systems are required; these facilities rely heavily on public communication facilities. Intruders can infiltrate the main terminal or remote terminal through some communication relays [20], as shown in Figure 3

3.3. Information Protection

(1) Firewall technology protects the internal network of the computer network from illegal access to the external network. It restricts access between internal and external networks by setting a set of security policies in the security settings options. Industrial information management systems often use powerful dedicated firewalls. Compared with firewalls commonly used in traditional IT networks, dedicated firewalls are more reliable and stable, can support a wide range of industrial protocols and in-depth data analysis, and can also perform many functions comparable to those of industrial information control systems, such as deep process-specific security and safety, custom settings, process control, auditing, and the ability to filter and block messages

(2) Intrusion detection methods are used to determine whether a system is subject to attack by collecting critical information about the system and a method that uses a predefined security policy. In the field of industrial control, antitheft systems are more complex, and their configuration often requires close integration with actual industrial production. For example, in industrial production, when an

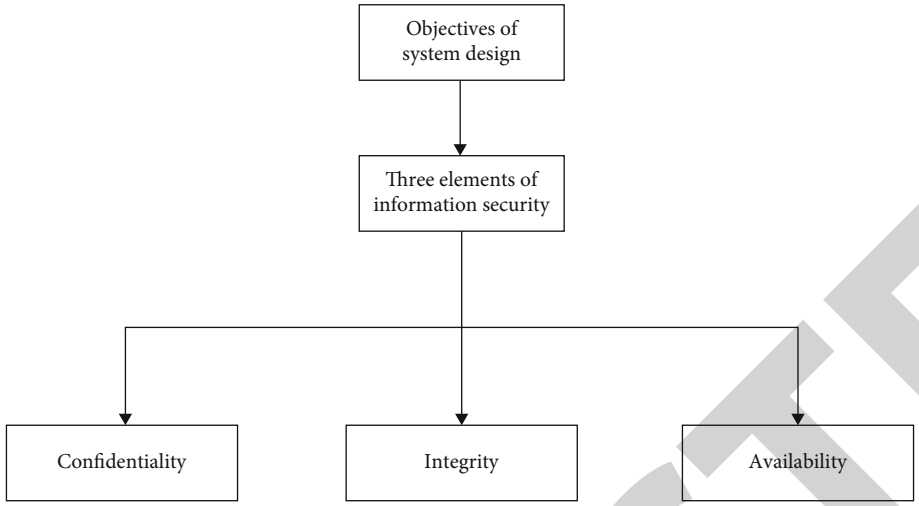

Figure 1: Objectives of the system design.

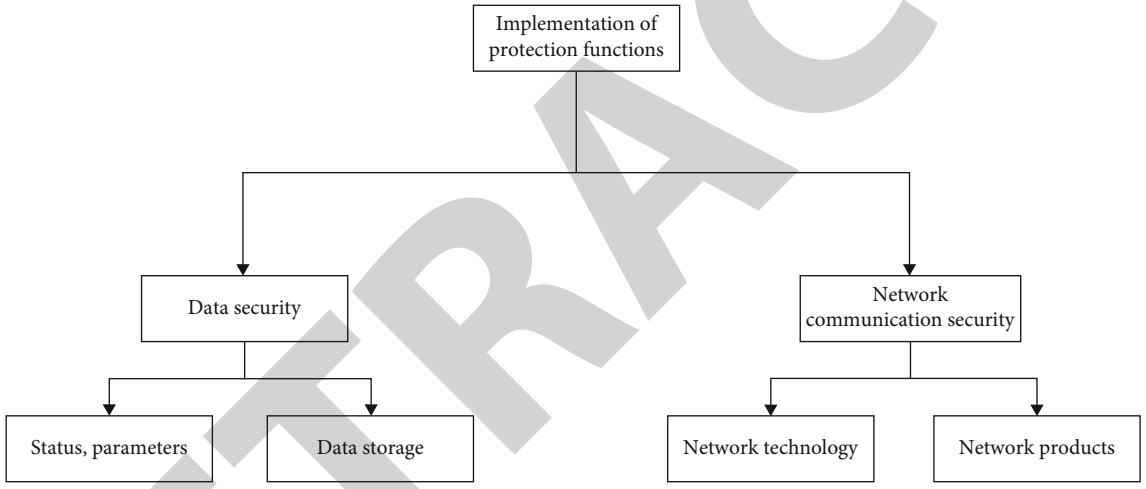

Figure 2: Implementation of the protection function.

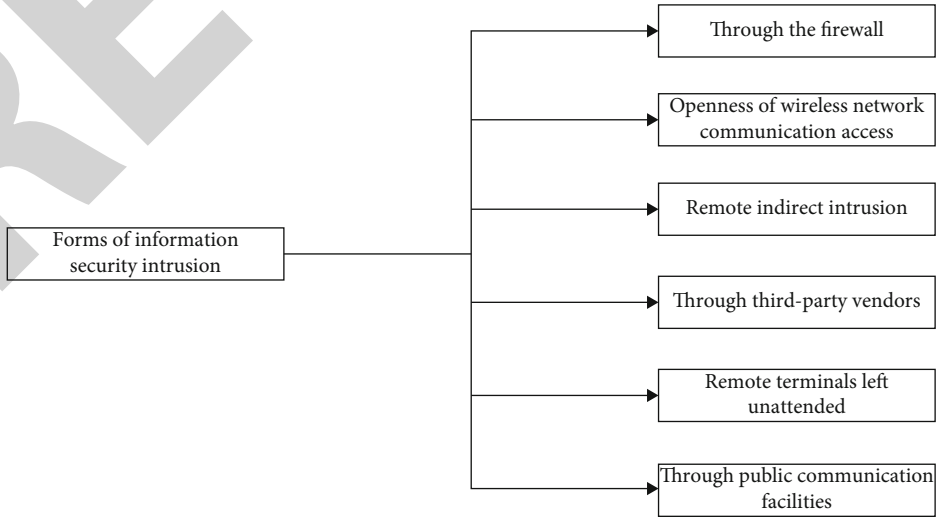

Figure 3: Forms of information security intrusion.

emergency occurs, all devices must be shut down immediately by defining an intrusion detection policy. After the system detects the intrusion in question and finds that it has caused damage to the system equipment, it can lock out certain equipment or complete the production process according to a predetermined processing sequence. Of course, theft prevention methods do not usually respond directly to theft, but the cooperation of field personnel is required to complete the process. In most cases, a burglary prevention system will detect a burglary in a room, sound an alarm, and respond to field personnel

(3) Intrusion detection methods of active defense technology can detect systematic intrusions and cooperate with personnel to respond but do not have the ability to actively defend against intrusions by themselves. The tactics for defending against intrusions are usually predetermined and then recorded in the system. Such defense tactics can remain in place for a long period of time, making the means of network detection more easily detectable. These shortcomings can be overcome by active defense techniques. Active defense technology not only detects burglaries but also takes appropriate protective measures depending on the burglary. Active defense equipment has a self-learning function. It can reconsider its defense strategy based on previously discovered intrusion intelligence in order to more accurately associate it with similar intrusions. In addition, an active defense system has specific predictive capabilities that enable it to analyze its own vulnerabilities and threats, predict possible attacks, and prevent them by taking comprehensive countermeasures against discovered attacks. Industrial control systems can use preemptive protection techniques such as "whitelisting," establishing reliable security networks and conducting regular security assessments. (4) Security verification method is a professional method to verify the most important information in the network using certain evaluation rules. In industrial management systems, it is often necessary to examine operational information, management log information, system file information and error log information, production log information, security policy information, and system operation information and to perform a series of information security checks. By evaluating and analyzing the above information, you can identify potential system vulnerabilities and security risks and then take targeted improvement or corrective measures. In technical control systems, depending on the requirements of real-time control systems, security inspection methods are typically used for real-time control; the collection of alarm information and equipment performance data in real-time data acquisition systems, processing and analyzing the data and identifying security risks in the control system. Employees are alerted and then use this information to perform the following operations

4. Results and Discussion

4.1. Monitoring and Warning Platform Architecture Design and Password Antitheft Technology System Design. Based on the above theory, the framework of monitoring and alerting platform architecture design and password antitheft technology system design is proposed, and the whole process includes four stages: system testing, attack risk testing, system risk assessment, and strategic decision making, as shown in Figure 4.

(1) Detecting abnormalities and attacks during system operation: placing detectors and monitors in the information and physical layers to collect information on equipment operation and system performance to determine whether there are intrusions or abnormalities in physical equipment and uploading relevant information to the risk assessment module for detecting abnormalities in the physical process, using the equipment operation parameters collected in the physical space to determine the equipment based on the characteristics of the equipment itself and its properties. Perform anomaly assessment and determine the equipment failure or fault type and its location. Intrusion detection: combining the collected asset state data with the information on the abnormal state of the physical process, analyze whether the information equipment is under information attack, and determine the type and location of the attack

(2) Assessment of attack danger with location information: predict the possibility of different attack parameters based on physical device abnormality information and test engine data, calculate the loss of different attack modes, and quantify the potential impact of information attacks on the site. Analysis of the attack information propagation process: build a model to describe the relationship between information attacks, device access rights and attack environment real-time attack data use, location information, structural information gap data and equipment communication model for prediction, and the type and likelihood of attacks. Site prediction: determine the process and accident model of the module physical cut model, describe the outline of the abnormal exposure of equipment, and calculate the value of accidental damage in various attack scenarios based on physical equipment and environmental anomaly information. Information attack risk calculation: combine the damage values in different attack scenarios and calculate the corresponding information attack risk values based on determining the risk and probability of various confirmed attack scenarios

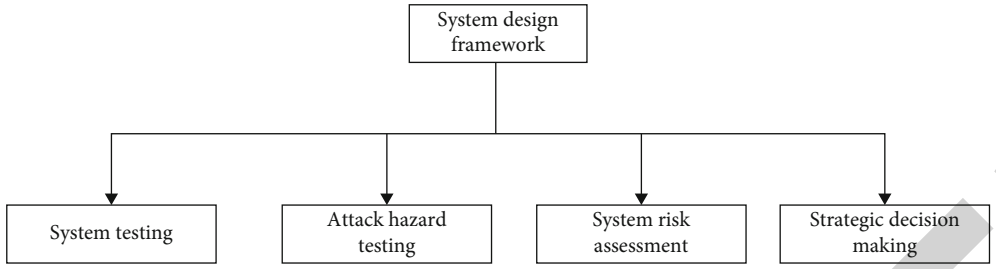

Figure 4: System design framework.

(3) System risk assessment: collecting site state information, modeling and describing physical network attributes, and deriving anomalies in the physical network distribution process. Based on the social attributes of the basic industrial infrastructure, the negative impact of the facility anomaly distribution process is quantitatively evaluated. Cascade effect analysis: a model describing the physical network topology properties and their dependencies was developed. The throughput of anomalous nodes is maintained, and the loops of the entire physical network are derived. Risk assessment: quantifying anomalous logistic losses considering the revenues of major industrial infrastructure owners, consumer demand for services, and market conditions

(4) Security strategy decision: coordinate security strategy decisions with system strategic planning based on information triggered by information attacks, the location and risk of damage to the system, combined with the system's own protective measures, and use cost-benefit assessment models as the basis for the most effective security strategy decisions. Develop potential site security strategies: multiple potential site security strategies have been developed to address information attacks during internal site communications, keeping the risk of information attacks below the "security threshold." Develop potential system scheduling strategies: global scheduling strategies are developed to prevent anomalous proliferation in the physical network and to ensure that the damage from system attacks is below certain "security" thresholds by accessing various potential system scheduling strategies. Develop optimal security strategies: analyze the coordination process between decision-makers and field systems, taking into account the operation of major industrial infrastructures, a combination of potential field security strategies, and a set of potential system planning strategies to maintain optimal security management strategies

4.2. Formulas and Algorithms. The monitoring and warning platform architecture design process is divided into three levels: the information attack level, the information flow level, and the management policy level. In order to describe the causal relationship between these three levels, Bayesian networks are established in conjunction with the definition of Bayesian networks. These processes include the following:

(1) Attack level information: the attacker scans the hardware vulnerability information and uses these vulnerabilities to access the device. Depending on the device access, the attacker uses the vulnerabilities of the target device to launch subsequent attacks. Create a description of the attack distance, as follows:

$$\varepsilon^{\partial} = \left(\partial, b^{\partial \longrightarrow \partial}, M^{\partial \longrightarrow \partial}\right), \tag{1}$$

where $b^{\partial \longrightarrow \partial}$ describes the conditional relationship between information attacks and $TM^{\partial \longrightarrow \partial}$ denotes the conditional probability of any information attack

(2) Current layer: the single subproject control module is designed as a fixed information flow structure that connects all subproject sensors into a single observation function. All management mechanisms consist of decision-making functions, and all execution mechanisms consist of execution functions. As a result, anomalous devices usually lead to failures and affect convection performance. For example, a Bayesian network describes the relationship between ∂ information FI attack attributes and streams as follows:

$$\varepsilon_i^f = \left[(\partial, \phi_i), \left(b^{\partial \longrightarrow \phi}\right)\right]. \tag{2}$$

Specifically, we use information flows that contain multiple elements, change the content of information, prevent information transmission, etc.

(3) Control strategy layer is shown as follows:

$$\varepsilon = [(\partial, \phi, s), b, M]. \tag{3}$$

According to the above analysis, the attacker uses the information layer device as an attack object to undermine

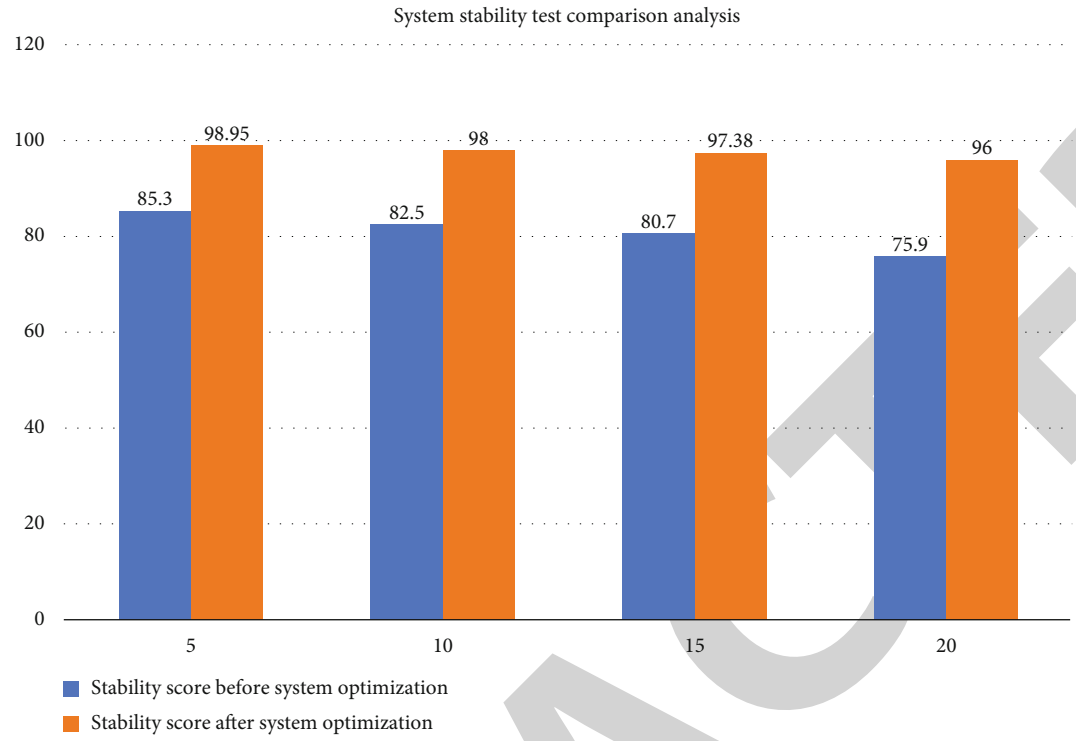

Figure 5: System detection stability analysis.

the website management policy. In this regard, the information propagation process model of information layer attack is introduced, including the attack level information, current layer, and control policy layer. The Bayesian network is shown as follows:

$$A = \begin{pmatrix} b^{\partial \longrightarrow \partial} & 0 & 0 \\ 0 & b^{\partial \longrightarrow \phi} & 0 \\ 0 & 0 & b^{\partial \longrightarrow s} \end{pmatrix}. \quad (4)$$

4.3. System Suitability Test. According to the construction of the above system algorithm system, the monitoring and warning platform architecture design and password antitheft technology system upgrade were carried out with the following comparative analysis:

(1) System optimization before and after the stability analysis: Simulation experiments are conducted on the system to analyze the stability of the system, assuming that the stability of the system is scored out of 100, the horizontal axis indicates the number of simulated intrusions, and the vertical axis indicates the stability score. When the number of intrusions is 15, the stability score of the system is 75.9; after system optimization, when the number of intrusions is 5, the stability score of the system is 98.95, when the number of intrusions is 10, the stability score of the system is 98, when the number of intrusions is 15, the stability score of the system is 97.38, when the number of intrusions is 20, the stability score of the system is 96. This shows that the stability of the system has been significantly improved after optimization. Therefore, in the field of industrial information protection, this system can play the ability of identifying risks very stably, as shown in Figure 5

(2) System detection security analysis: for the system simulation experiment, use network hacking and other means to analyze the stability of the system, assuming the system security out of 100 points, the horizontal axis indicates the number of intrusions, and the vertical axis indicates the security score, from the data provided: before the system optimization, when the number of intrusions is 5 times, the security score of the system is 88.5 points; when the number of intrusions is 10 times, the stability score of the system is 85 points. When the number of intrusions is 15, the stability score of the system is 83.65; when the number of intrusions is 20, the stability score of the system is 80.86; after system optimization, when the number of intrusions is 5, the security score of the system is 99.25; when the number of intrusions is 10, the stability score of the system is 98.75. When the number of intrusions is 15, the stability score of the system is 98.65, and when the number of intrusions is 20, the stability score of the system is 97.75. It can be seen that when the number of intrusions is more after system optimization, the security score of the system is lower, but the scores are above 95, so the security of the system is very reliable, so in the field of industrial

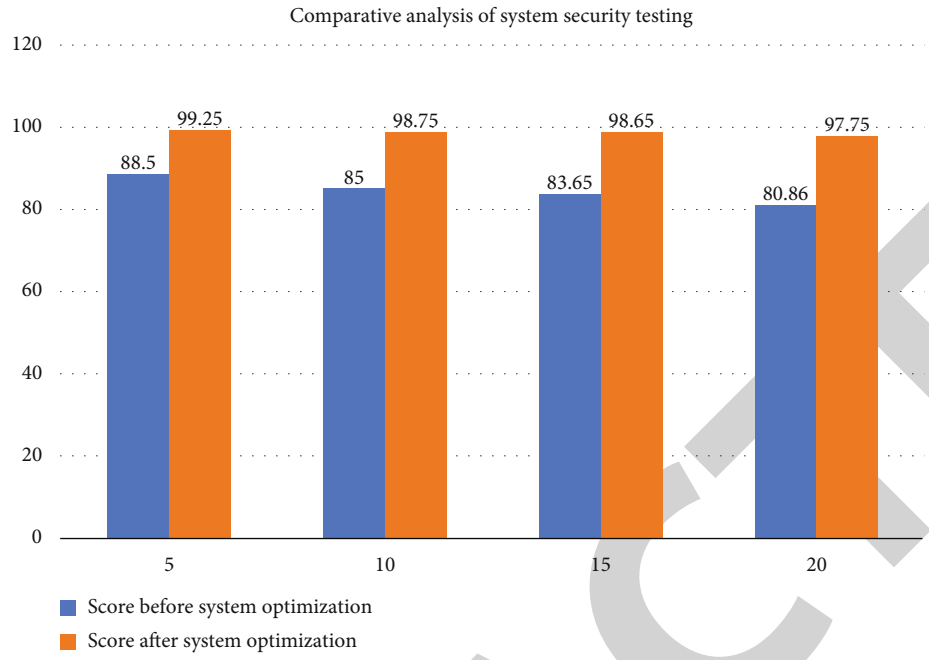

Figure 6: System detection security analysis.

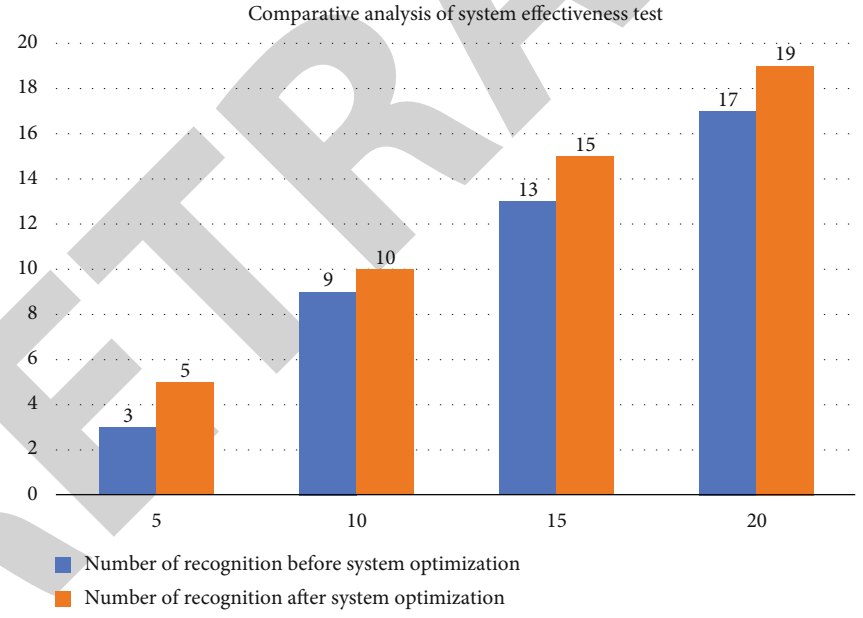

Figure 7: System detection effectiveness analysis.

information protection, this system can play a very safe ability to identify risks, as shown in Figure 6

(3) System detection effectiveness analysis: Simulation experiments are conducted on the system, and the horizontal axis in the figure indicates the number of simulated intrusions and the vertical axis indicates the number of effective identifications: before the system optimization, when the number of intrusions is 5 times, the system effectively recognized 3 times; when the number of intrusions is 10 times, the system effectively recognized 9 times; when the number of intrusions is 15 times. After system optimization, when the number of intrusions is 5, the system effectively recognizes 5 times; when the number of intrusions is 10, the system effectively recognizes 10 times; when the number of intrusions is 15, the system effectively recognizes 15 times; when the number of intrusions is 20, the system effectively recognizes 19 times. The more the number of intrusions, the

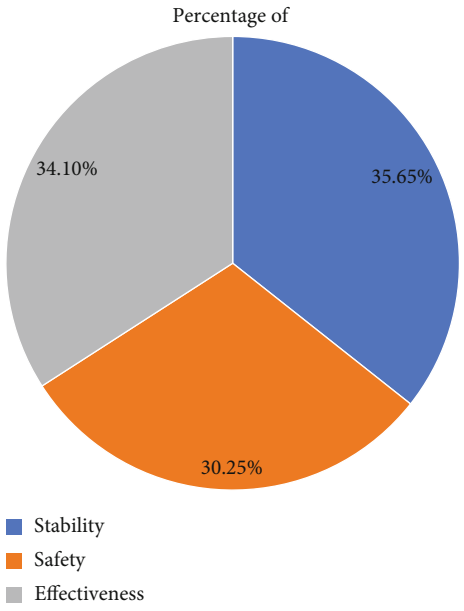

Figure 8: Analysis of the three major functions.

system's basic can be effectively identified; only a very small number of cases can not be identified, so the supervision system is more effective, as shown in Figure 7

(4) Analysis of the proportion of the three major functions: according to the data analysis, the three major functions are stability accounted for 35.65%, security accounted for 30.25%, and effectiveness accounted for 34.1%; it can be seen the proportion of the three major functions in a balanced posture; the system design and functional testing deployment have a very important position, as shown in Figure 8

5. Conclusion

Industrial information security is an important part of the national security strategy that affects the economy and people's lives. It is a new area of occupational security that is very modern, complex, and promising. It covers many areas of information security of industrial information control systems. Its main task is to ensure infrastructure security and industrial automation, as well as to provide economic and social benefits to people in key sectors such as transportation and energy. In recent years, with the rapid development of industrial information technology, cybersecurity threats have grown, and cyberattacks have become more frequent. We are alarmed by many attacks. Once attacked, there is a high potential for catastrophic consequences. In recent years, the development of industrial security around the world has also made people feel alarmed about how to ensure industrial information security. The current industrial information security monitoring system is a large and complex system development process. As the connection expands, security risks increase, and attack opportunities and channels increase.

First, there are security gaps in industry regulation. As a result of the convergence and development of these two technologies, malicious attacks have been perpetrated using system vulnerabilities, remote access theft, and phishing as important means in the design of industrial information control systems (SRP). Traditional defense products are unable to effectively respond to today's complex and diverse security threats.

Second, the operating environment has become more open and networked. The primary target of virus attacks is the host computer, which is largely separated, the industrial environment lacks basic protection, and operators lack the necessary hostile knowledge and threat awareness.

Third, supply chain risks have increased. In China, the independence of key technologies, software, and hardware in cyberspace is weak, especially due to the increased risk of storing and deploying new technologies and the increased threats and pressures from cyberspace.

Fourth, attacks are minimal. Due to the emergence of various hackers, there are large gaps in the hardware used in industrial information control systems that can be found through different network channels, as well as through different network channels. There are many dangers of virus entry and illegal access.

Fifth, as geopolitical competition intensifies, industrial information control systems are easy targets for interstate cyber confrontation and hacking. The cybersecurity situation is becoming increasingly complex, and industrial networks have become the most important area of geopolitics. In recent years, China's rapid industrial development and information technology development face serious security threats and the urgent need for information security. The gradual increase in national demand and support for occupational safety management systems has led to a shift from production management systems to the information security industry and the sustainable development of the industrial control and information security industry. In this new paradigm, we must upgrade the existing industrial cybersecurity system, establish a wide range of industrial cybersecurity technology system, and build an industrial cyber protection system based on sensing, early warning, monitoring, and emergency response. It is a strategic choice for infrastructure-first industries to jointly develop cybersecurity network coordination mechanisms between government and social organizations, enterprises, and research institutions and to build government, industrial, educational, scientific, and industrial ecosystems using integrated industries.

Data Availability

The dataset is available upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Retraction

Retracted: Analysis on the Coupling Relationship between Natural Resource Loss and Environmental Pollution Cost Accounting in Chongqing

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] F. Chen and Z. Zhao, "Analysis on the Coupling Relationship between Natural Resource Loss and Environmental Pollution Cost Accounting in Chongqing," *Journal of Sensors*, vol. 2022, Article ID 5223502, 11 pages, 2022.

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Research Article

Analysis on the Coupling Relationship between Natural Resource Loss and Environmental Pollution Cost Accounting in Chongqing

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Natural resource loss and environmental pollution are the focus of attention at present. Based on the analysis of the coupling relationship between natural resource loss and environmental pollution cost accounting in Chongqing, this paper makes a comprehensive analysis of the accounting results. First of all, we should define the loss of natural resources and set the direction of research and development, establish the ecosystem data model, calculate the environmental pollution cost, and display the calculation results. The results show that (1) air pollution is the focus of environmental pollution. On the premise of ensuring production quality, control the number of emissions from production and reprocess the emissions. (2) In the process of paying attention to water and soil resources, detect and protect water resources and soil, and calculate the ecological value of water resources and soil. Pay attention to the benefits between water and soil and transform and optimize the ecological value system of natural resources.

1. Introduction

In a special sense, any natural resources on the earth can be exhausted. If they are willing to maintain them or do not prevent their self-regeneration, they may eventually be destroyed [1]. Global Macroeconometric Model E3MG is the current global energy technology substitution model. It has the characteristics of dynamic logistics technology transformation and induced technological change. It features the use and consumption of natural resources in 20 regions around the world. Continuous technology transformation and decarbonization are driven by carbon price [2]. We were asked to talk about the Roma club model we have been studying. After forming a bad view of the model, we decided to discuss it only in an initial part, and that was written in a controversial way. Those who have a lot to do with the debate on world dynamics will understand why we think it is necessary to express ourselves in a more appropriate way than we usually think [3].

Considering intergenerational equity, reconsider the optimal pricing and use of natural resources. Suppose that in a just economy, each generation chooses a plan to maximize its own effectiveness, subject to the constraint that the plan should not be exploitative; that is, each generation will not use its earlier time point to future generations. Research shows that if the production cost of alternative energy (such as solar energy) is high enough relative to the stock of naturally stored energy, the constraint of justice will lead to low initial energy utilization, but later higher [4]. Well-designed regulation can curb politically driven inefficiency, but it can also exacerbate distortions if politicians control regulators. We studied the impact of strengthening India's transmission regulatory structure on groundwater exploitation, in which electricity is the key input, and we found evidence of politicians' regulation. The guidance of our model is conducive to national candidates, who have greater motivation and ability to choose regulators. Using politicians from national and regional political parties competing for parliamentary seats under 1996-2000 from India, we show that authorized regulators have expanded distortions in groundwater exploitation. There are six years of nationally representative groundwater data. We estimate that in the highly competitive constituencies won by national political party candidates, regulatory capture has led to an additional 2.75 meters drop in groundwater level.

The short-term cost of highly competitive geographical constituencies is about 18% reduction in agricultural production [5]. Based on the environmental governance cost method, the environmental pollution cost of Chongqing from 2008 to 2015 is estimated and analyzed [6]. In order to correctly calculate the social and economic development efficiency of Guanzhong area in Shaanxi Province in recent 10 years, an environmental cost accounting system composed of environmental degradation value, environmental protection expenditure, and natural disaster compensation is established. The results show that GDP increased in 2010, but the cost of environmental pollution increased by 17%. The past two years have shown that the environmental pollution in Guanzhong area is serious, the level of social and economic development and environmental benefits are low, and the environmental situation needs to be improved [7]. Managing and controlling the environmental costs of contaminated sites can be a cumbersome task, followed by a frustrating accounting attempt to identify, track, compile, audit, estimate, or forecast these expenses. How can you be sure that the money you spend is reasonable and habitual? Where is the statistical analysis comparing the cost of cleaning up contaminated facilities? What are the monetary and regulatory responsibilities associated with this work? How will the name of pollution affect the value of property and adjacent properties? In fact, these are just a few questions raised by the company manager when it comes to the cleaning of large Superfund sites or simple leaking underground storage tanks. As the process progresses slowly, the costs associated with clean-up activities increase exponentially. However, with an environmental cost management plan, companies can control and manage costs while increasing profits [8]. Environmental pollution cost is a measure of the damage to the environment caused by land development projects. It should be an important part of enterprise decision-making. The so-called ecological resources and environmental cost refers to the environmental and economic losses caused by human activities, which includes degradation cost and governance cost. Firstly, we use the market value method to establish the cost equation of water, energy, and land environmental degradation. In addition, we use principal component analysis to select two main factors affecting the cost of environmental control: the level of environmental pollution and the level of enterprise environmental management. We use entropy weight method and analytic hierarchy process to normalize the management level and then establish the project pollution control cost accounting equation. The enterprise environmental pollution cost accounting system is conducive to the accurate accounting of the environmental pollution cost of land development projects. Reasonable control of environmental pollution is conducive to the sustainable development of economy and society [9]. The accounting model of ecosystem management is established to collect the specific data of environmental ecology and biology. And use MATLAB software to complete the construction of cost audit model. In the comparative price audit experiment focusing on January, we choose the experiment of traditional management cost audit mode and the construction of small- and medium-sized enterprise cooperation cost audit mode. From January to June, the cost of ecological environment pollution is calculated from the cost of soil management, water management, and air management, and the results are compared with the actual cost [10]. The relationship between metropolitan scale expansion and land use intensity is a hot topic in Chinese Mainland in recent years. Although many scholars have discussed this topic from a theoretical perspective, unfortunately, there is a lack of empirical research in this area. In view of this, this study mainly makes an empirical investigation on Chinese cities. Firstly, the urban land use intensity coefficient is analyzed and established around the main components, and then, the results are verified by structural equation. The results show that urban land use intensity has both positive and negative effects on urban scale. In particular, the agglomeration effect of land and capital is positive, and the substitution effect between them is negative. The results of this study especially solve the coupling relationship between urban size and land use intensity in Chinese Mainland. The results show that when the level of nonland factors increases, the urban land use intensity will increase [11]. The entropy method is used to analyze and finally put forward corresponding suggestions for the problems existing in the current development model. Chongqing's economic development and ecological environment have been significantly improved from 2001 to 2010, showing a stable upward trend. In 2010, it was in a state of coordinated development, and the governance of ecosystem obviously lagged behind the economic development. In addition, there are differences in the development of each subsystem, that is, economic level development and economic efficiency [12]. In order to study the coupling relationship between the flow and pyrolysis of regenerative cooling advanced aeroengine microchannel endothermic hydrocarbon fuel, the characteristic time is defined to describe the time scale of flow and pyrolysis reaction in the pyrolysis reaction flow field. Damkohler number (DA) is used to quantitatively describe the relationship and coupling degree of flow and pyrolysis reaction in microchannel in terms of characteristic time. A one-dimensional model is established to describe the coupling relationship between flow and pyrolysis reaction, which is verified by experimental data. The simulation and experimental results show that DA can quantitatively describe the relationship and coupling degree between flow and pyrolysis reaction. According to the distribution of Da and chemical heat sink, the flow field can be divided into three areas: frozen flow, nonequilibrium flow, and equilibrium flow. Each region shows different coupling characteristics of flow and pyrolysis reaction, resulting in different distribution of chemical heat sink. Especially between the nonequilibrium region and the equilibrium region, the release rate of chemical heat sink is the largest. And the change of flow rate has no effect on the maximum release rate of chemical heat sink [13]. Because the query intention is not accurate, web database users often use a limited number of keywords that are not directly related to their accurate query to search information. Semantically similar keyword queries are challenging but help specify the intent of such queries and provide more relevant answers. By extracting the semantic relationship between keywords and keyword queries, this paper proposes a new keyword query method, which generates idiom semantic approximate answers by identifying a set of keyword queries related to a given keyword query from the query history. In order to capture the semantic relationship between keywords, a semantic coupling relationship analysis

model is introduced to model the coupling within and between keywords. Based on the coupling relationship between keywords, the semantic similarity of different keyword queries is measured by semantic matrix [14]. The oil chamber of hydrostatic table of modern heavy-duty CNC machine tool is designed under the condition that the working load acts on the oil chamber equally. However, when the workpiece leaves the rotation center of the worktable, the working load acts on the oil hole unevenly, and the performance indexes of the oil hole such as force, oil film thickness, hydraulic damping, and rated flow are different. Based on the eccentric working load, the coupling relationship between oil holes is analyzed, and the expression and relative bar graph are given. In order to achieve the processing quality and prevent the complete wear of the machine tool, it is best to adjust an oil bag so that the oil film thickness of all oil bags is the same. While adjusting an oil bag, the oil bags are coupled with each other, and the performance indexes change synchronously [15].

2. Natural Resource Loss and Environmental Pollution Cost Accounting

2.1. Natural Resource Loss and Environmental Pollution Cost Accounting Definition of Natural Resource Loss. To calculate the loss of ecological environment and natural resources, we must first clarify what is loss, that is, the definition of loss. The definition of loss is the actual value of asset value at different times. Generally, ordinary assets in reality become depreciation, while those used for environment and natural resources become loss. In addition, there are two different descriptions of natural loss, one is economic damage, and the other is physical loss.

First, let us talk about what is physical loss. Physical loss is defined as the decline of the ability and services provided by the original assets for products. Take natural resources and ecological environment as examples, such as mineral resources, water resources, soil resources, vegetation resources, or fresh air. Economic loss refers to the decline of the stock value of the original assets, which is defined as the change of the value of assets over time. The difference between the two concepts is that physical loss may lead to economic loss, but economic loss does not necessarily need physical loss, because economic loss is the product of price and quantity and because economic loss is the product of asset price and quantity. For example, the manufacturing capacity of a manufacturing plant's production machines has not changed, but the products it produces are no longer popular and used by the public, so the value of the products will be devalued, resulting in the devaluation of the value of the machines and the devaluation of the economy. This example can also be associated with the asset stock of natural resources and environment. If an ecological park, if the tourism activities of the ecological park increase, it will inevitably lead to the decline of the environmental quality of the tourist attractions of the ecological park. As the number of tourists increases, the value of these activities may not decrease, but increase. Therefore, the asset value provided by environmental resource assets and natural resource assets will lead to economic depreciation or economic appreciation. Whether environmental and natural resource assets or assets in a general sense, their physical changes have nothing to do with economic losses.

2.2. Depletion of Natural Resources and Sustainable Development. The concept of loss is closely related to the concept of sustainability, and loss plays a very important role in the concept of income, especially in the sense of sustainable income. PEZ collated the literature on sustainability in the World Bank report. It can be roughly divided into three categories: one is economic sustainability, the other is environmental sustainability, and the third is to maintain environmental sustainability without reducing economic level (or maintain sustained economic growth without reducing environmental quality). However, some people confuse the above three concepts. They either believe that environmental sustainability is a necessary condition for economic sustainability, or on the contrary, they believe that only economic sustainable development can promote environmental sustainability. Different concepts reflect different people's views on different environmental and economic priorities. These different concepts of sustainability are closely related to the two concepts of loss: those who support extreme environmental sustainability advocate actions to reduce or even avoid physical losses in the environment and those who support economic sustainability advocate certain actions to reduce or avoid economic losses of environmental assets. To apply the above concepts to accounting, we must understand the relationship between income and loss.

2.3. Income and Loss of Natural Resources. Income refers to the corresponding reward from work or income from other labor income, such as debt income. But an employee's salary or debt is paid back on a monthly basis. Can we say that the income after the end of the month is zero? Hicks suggested that the focus should not be on income itself, but on the ability of these incomes to generate consumption. Therefore, he believes that the goal of calculating income in practice is to give a person or a team the way of spending power. He means that they will have better spending power than before. Therefore, Hicks believes that income is the amount of consumer goods and services they can control, but the premise is that their consumption will not damage their future consumption ability. Therefore, Hicks income means the significance of sustainable income. The concept of Hicks income applies to national accounts, i.e., net national products or net domestic products. Assets provide a series of products and services in the market and generate value. The reward obtained in a certain period of time is income. First, take V0 as the asset value in the first year and Q1 and Q2 as the value of products and services provided each year, that is, the total income. The calculation process of the model is shown in Figure 1:

3. Natural Resources and Environmental Pollution Accounting Algorithm

The key of pollution cost accounting is environmental value accounting. Pollution cost mainly includes pollution cost and environmental damage cost. Environmental governance cost refers to the current governance cost. Environmental damage cost refers to the actual damage to environmental functions

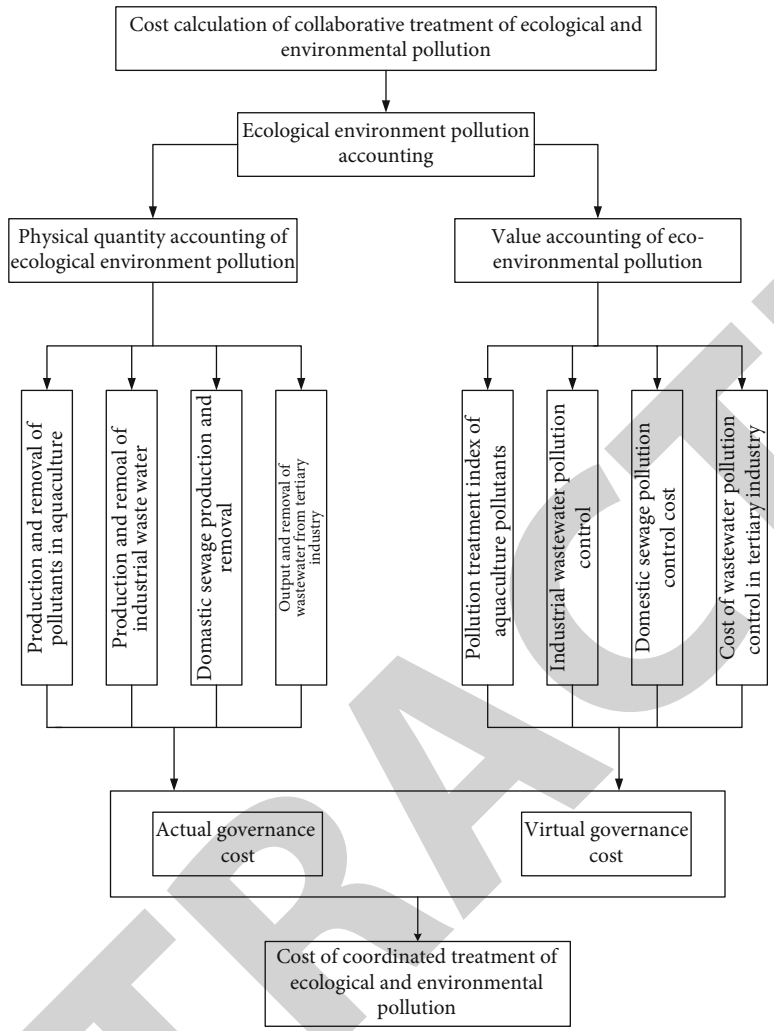

Figure 1: Accounting process of cost accounting model.

caused by pollutants discharged in the process of production and consumption lower than the current treatment level. It is calculated according to the treatment cost method, that is, the treatment cost required to prevent the deterioration of environmental functions. It is assumed that the pollution treatment cost is equal to the damage caused by emission pollution. The accounting methods of environmental treatment in China mainly adopt the quota method of pollutant treatment fee, the standard characteristic method of wastewater calculation, the treatment cost coefficient method, the unit cost analysis method, and the unit cost analysis method adopts the physical quantity of pollutant discharge and treatment and the unit treatment cost of pollutants to calculate the treatment cost, including the depreciation cost of fixed assets, maintenance cost, labor cost, power consumption, and consumption of various materials. The calculation method of environmental pollution can help us calculate the pollution cost of environmental pollution.

3.1. Ecological Environment Pollution Control Standard. After establishing the calculation model, we need to coordinate the treatment and calculate the cost according to the ecological and environmental pollution.

The benefits of pollution control methods are

$$\eta^i = \frac{I_i - E_i}{S_i} \frac{E_i}{I_i}, \tag{1}$$

where ηi represents the treatment cost of pollutants, Ei represents pollutant emission, and Ii represents pollutant removal.

The calculation formula of pollutant cost is

$$\gamma_{\mathrm{i}} = \frac{\eta_i}{\sum_{i=1}^{n} \eta_i} i. \tag{2}$$

It is the calculated cost coefficient γ_{i} obtained from the calculation of certain pollutants, that is, the proportion of waste water in the total treatment cost. The greater its value, the more serious the waste water pollution in a certain area, that is, the greater the importance of treatment.

In formula (2), γ_{i} is the calculated cost coefficient of class I pollutants, that is, the proportion of waste water in the total treatment cost, and η is the treatment benefit of the i -th pollutant.

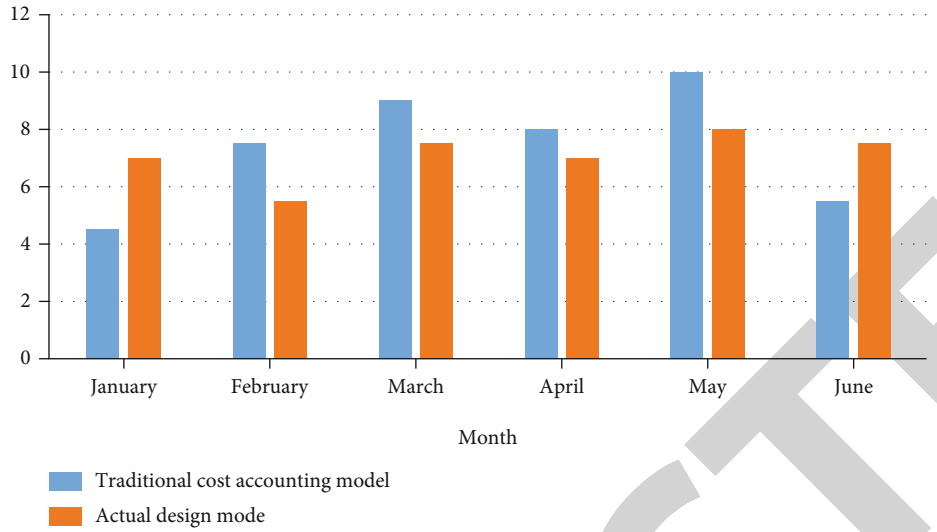

Figure 2: Comparison of land governance cost accounting results.

Calculate the unit treatment cost of the i-th pollutant, and the formula is

$$C_i = \frac{C_i \cdot \gamma_i}{M_i}, \tag{3}$$

where C_i is the accounting cost of major pollutants. By combining the above formulas, the pollution control cost can be calculated.

3.2. Agricultural Environmental Cost Calculation. From the characteristics of water pollution and natural agricultural economic development in Chongqing, the crops mainly focus on rice, corn, and sweet potato. By calculating the output of crops, taking the market price of various crops every year as the shadow price, the agricultural environment cost caused by water pollution irrigation is calculated through the shadow price calculation method:

$$M_{P\text{agriculture}} = \sum_{i=1}^{n} \partial P_i S_i Q_i. \tag{4}$$

$M_{P\text{agriculture}}$ is the cost of ecological damage to the environment, which is the product of the area of the polluted crop irrigation area and the treatment cost of transforming the polluted area into natural irrigation area. When its value is larger, it means that the pollution of the local crop irrigation canal is more serious.

In formula (4), P_i is the price of a crop; S_i is the specific planting area of a crop; Q_i is the unit area planted for a crop; ∂ is the proportion of polluted areas that do not meet the requirements of crop irrigation.

The shadow price calculation method is used to explore the minimum damage caused by water pollution to human health. The operating cost of water supply generated by various water supply companies in Chongqing is the cost of creating a healthy environment for adults.

Shadow engineering method, also known as alternative engineering method, is a method of engineering substitution; that is, in order to estimate a very lost project with impossible direct results, the implementation effect of fake and real projects is similar, and the economic loss of special evaluation items is replaced by the construction cost of the project. Shadow engineering method is a special form of restoration cost. After a certain link is polluted or broken, it is a method to manually build a project to replace the original environmental function and use the cost of building the project to estimate the economic loss caused by environmental pollution or damage.

$$M_P = QC. \tag{5}$$

Through the shadow engineering method, if the sewage treatment cost of the whole city in a certain year is the environmental cost of the damage to the ecological environment caused by water resources pollution:

$$M_{P\text{living}} = Q'C'. \tag{6}$$

The calculation formula of total environmental cost is as follows:

$$M_P = M_{P\text{agriculture}} + M_{P\text{people}} + M_{P\text{living}}. \tag{7}$$

3.3. Economic Loss Analysis of Water Environment Pollution. The economic loss of water pollution belongs to the category of ecological economy. In principle, this is the economic tax in the process of energy emission of pollutants in the ecological environment. This natural eco economic development phenomenon is like the source-level correlation in Linderman ecosystem and echoes with the linear relationship between adjacent nutrient source levels described in Linderman. This also means that water resources and environmental pollutants that do not enter the ecosystem. The economic loss of water resources and environmental pollutants entering the ecosystem is the economic manifestation of pollutants in the water

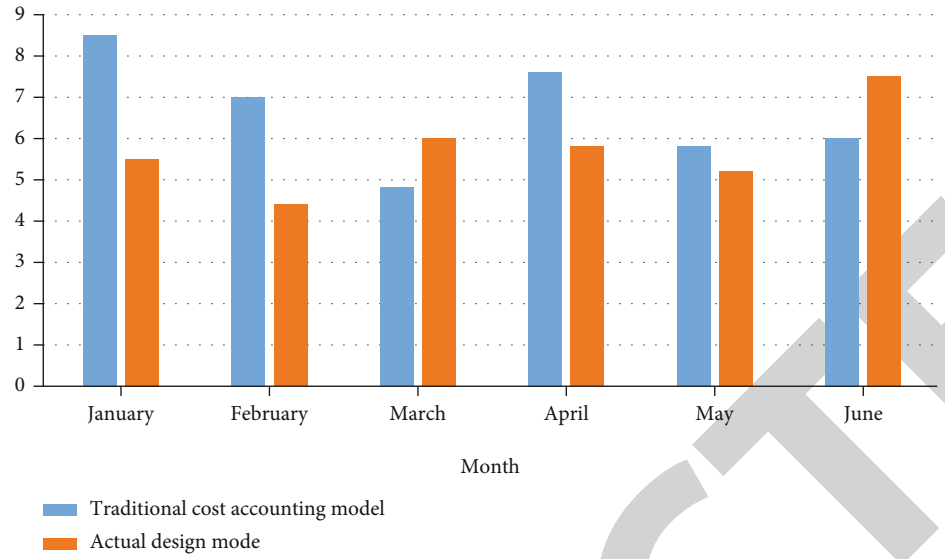

Figure 3: Comparison of water source treatment cost results.

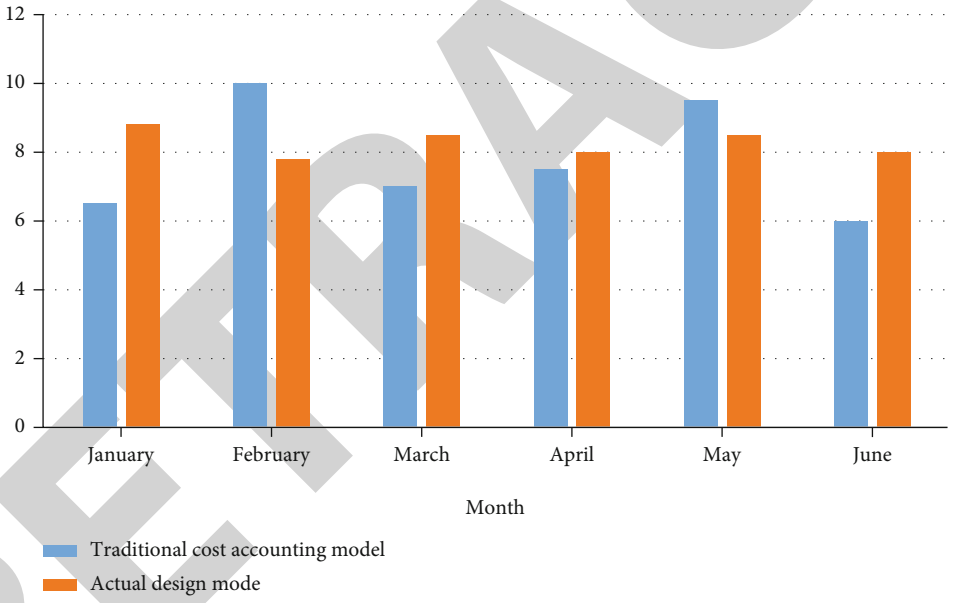

Figure 4: Comparison of atmospheric treatment cost results.

resource environment in the process of adjacent energy digestion, which conforms to the linear energy relationship between adjacent ecological environments. The expression is

$$M_E = K \times M_P, \tag{8}$$

where K is the economic loss coefficient of water pollution in the economic analysis of water pollution. The greater its value, the greater the severity of water pollution, and the more it is necessary to analyze and calculate the value of water resources.

The value K is calculated as follows:

$$K = \frac{M_E}{M_P}. \tag{9}$$

3.4. Comparison of Evaluation Methods of Environmental and Natural Resource Loss. The value of an asset depends not only on its value at any time but also on all future values. When economic loss is defined as the change of asset value over time, it is necessary to estimate the future variables. In theory, it can be overcome by some methods. In practice, we use the market price of existing assets to reflect the value of assets. The depreciation date of assets in a general sense can be measured by the observed changes in market prices. However, future price changes will affect the calculation of depreciation. In practice, some simple methods are often used to deal with the depreciation of ordinary assets. For example, linear depreciation is one of the most commonly used methods. It is much more difficult to calculate the loss

Table 1: Physical quantity statistics of industrial air pollution in Chongqing.

Project		2008	2009	2010	2011	2012	2013	2014	2015
SO_2	Production	10222.76	99116.03	133163	201383.2	335225.36	236133.4	26179.28	300811.48
	Removal	58106.76	4826.41	79163.4	102173.22	234656.8	145518.7	158479.92	206112.85
	Emissions	52116	50989.89	53546.4	99210.055	100568.56	90614.7	110699.36	94698.63
NO_X	Production	24988.69	26898.49	44245.5	80463.649	85591.77	79477.3	94205.49	88947.38
	Removal amount	2889.17	2832.65	2381.98	1862.608	6415.32	9366.81	26433.49	19515.43
	Emissions	22099.52	24065.84	41863.6	78601.041	79176.45	7010.49	67672	69431.95
Particulate matter	Production	525566.8	632263.4	191998	1181227.8	1631288.8	1597575	1981611.92	2080893.93
	Removal amount	491790.6	598353.7	1572488	1131272.5	15789944	1544949	1913256.44	116240.63
	Emissions	33776.2	33909.79	47510.04	49955.376	52294.37	52626.09	68355.48	84653.31

Unit: t.

Table 2: Statistics of industrial waste gas treatment in Chongqing.

Project	2008	2009	2010	2011	2012	2013	2014	2015
Operation cost of industrial waste gas treatment facilities	24050.3	23796.9	32957.1	6123.2	61232.2	77800.4	94039.7	91943.8
Operation cost desulfurization facilities	13132.5	12921.1	13805.8	9127.9	33916.8	34114.9	44497.3	53922.2
Operation cost of denitration facilities	—	—	—	1388.3	2148	9237.6	12181.9	16527.7
Operation cost of dust removal facilities	—	—	—	16396.6	25160	17300.4	18023.2	17428

Table 3: Physical quantity statistics of urban domestic waste gas in Chongqing.

Project		2008	2009	2010	2011	2012	2013	2014	2015
SO_2	Removal amount	1251	1224	1285	3198.4	3199	3199	3195	3820
NO_X	Removal amount	177	186	335	558	599	599	558	753
Particulate matter	Removal amount	878	882	1235	548.38	1771	1771	1769	2115

Unit: t.

of environmental protection goods without price market transaction. In theory and practice, there are three common methods to evaluate the loss of environment and resources: repetition method or net rent method, elasticity method, and present value method.

3.4.1. Net Rent Method. The net rent method is used when the environment and resources are limited and the ecological environment is nonrenewable. Under some assumptions, the net rent method repeatedly derives observable initial reports and natural resource losses, so the net rent method simplifies the pressure of calculating estimates. A limited and nonrenewable natural resource has a certain market price. For example, the value of polluted natural water resources can be calculated by the indirect loss of water resources, resulting in the reduction of income brought by crop production. The value of a limited natural resource and environmental asset is the sum of the value of the products and services of the natural resource and environment in each year in the future:

$$PV_0 = \frac{R_1}{1+r} + \frac{R_2}{(1+r)^2} + K + \frac{R_T}{(1+r)^2} = \sum_{t=1}^{T} \frac{R_t}{(1+r)^2}. \quad (10)$$

In formula (10), it is the value of assets and services in a certain year, t is the service life of assets, and R is the market interest rate.

Further assume that it increases with the market interest rate, that is,

$$R_t = R_1(1+r)^{t-1} \cdot \cdots\cdots\cdots\cdots. \quad (11)$$

On the premise of perfect market competition and the pursuit of profit maximization and free access, the return rate of capital market is the same in theory. However, in reality, due to the incomplete publicity of resources and market, this assumption will have some problems. These assumptions have produced quite attractive results:

$$PV_0 = \frac{R_1}{1+r} + \frac{R_2}{(1+r)^2} + K + \frac{R_T}{(1+r)^{\mathrm{T}}} = \frac{R_1}{1+r} + \frac{R_1(1+r)}{(1+r)^2} + K + \frac{R_1(1+r)^{T-1}}{(1+r)^{\mathrm{T}}} = \sum_{i=1}^{T} \frac{R_1(1+r)^{t-1}}{(1+r)^t} = \sum_{i=1}^{T} \frac{R_1}{(1+r)} = T\frac{R_1}{(1+r)}. \quad (12)$$

Table 4: Calculation results of waste gas simulation treatment cost in Chongqing.

Project		2008	2009	2010	2011	2012	2013	2014	2015
Virtual governance cost	SO_2	282.7	328.0	223.3	291.1	460.6	748.6	897.8	1000.18
	NO_X	132.6	143.0	249.6	415.7	187.3	551.2	257.2	637.0
	Particulate matter	15.8	13.2	16.6	7.68	24.8	19.5	15.9	19.0

Table 5: Calculation results of atmospheric environmental pollution in Chongqing.

Project	2008	2009	2010	2011	2012	2013	2014	2015
Actual governance cost	24137.1	24006.7	328877.8	26912.2	61224.8	60652.9	74702.4	87869.9
Virtual governance cost	29281.5	32587.3	41460.0	68999.8	42515.4	42515.4	64089.5	85899.8
Total	52418.6	56594.0	74337.8	95912.6	103740.2	103740.2	13879.9	173767.7

Then, the present value of assets in the next period is

$$PV_0 = \frac{R_2}{1+r} + \frac{R_3}{(1+r)^2} + K + \frac{R_T}{(1+r)^{T\text{-}1}} = \frac{R_1(1+r)}{1+r} + \frac{R_1(1+r)^2}{(1+r)^2} + K + \frac{R_1(1+r)^{T-1}}{(1+r)^{T\text{-}1}} = \sum_{t=2}^{T} \frac{R_1(1+r)^{t-1}}{(1+r)^{t-1}} = (T-1)R_1. \tag{13}$$

3.4.2. El Serafy Law. From the actual use situation, the net rent method is indeed relatively simple and can be used by a large number of users. However, the net rent method is related to the real growth rate of RT equal to the interest rate, and the net rent method uses different hypothesis theories for the calculation target. The net rent method divides the total income of self-owned assets into two parts, one is the actual income, and the other is the income generated by the use of energy intensive assets. The net rent method itself believes that as long as it is sustainable, we should invest more energy-intensive income in a limited time. In the future, we can create more sustainable income through investment, and these investments are our real income. According to the mathematical formula, R is the interest level, r is the annual total income, which can be set as a constant, and X is the annual actual income; then, the present value of the balanced actual income is

$$V_0 = \sum t = 1 \infty R(1+r) = X_r. \tag{14}$$

The actual present value of annual income r within the limited exploitation life of resources is

$$W_0 = \sum t = 1 \infty R(1+r) = R_r(1 - 1(1+r)T). \tag{15}$$

Assuming the above two are equal, the actual benefit X is

$$X = R - R(1+r)T. \tag{16}$$

3.4.3. Net Present Value Method. The sum of product value and service value generated by natural resources and ecological environment in the coming years is as follows:

$$PV_0 = R_{11} + R_2(1+r)2 + K + R_T(1+r)T = \sum t = 1TR_t(1+r). \tag{17}$$

If the basic discount rate does not change, one year later, the sum of the value of natural resource assets and the present value of the value generated by the first phase environment is

$$PV_1 = R_{21} + r + R_3(1+r)2 + K + R_T(1+r)T - 1 = \sum t = 2TR_t(1+r)t - 1. \tag{18}$$

All RT from the second year to a certain year is discounted to the first year and summarized, so that the economic depreciation between period 0 and 1 is

$$D_1 = PV_0 - PV_1 = \sum_{t=1}^{T} \frac{R_t}{(1+r)^t} - \sum_{t=2}^{T} \frac{R_t}{(1+r)^{t-1}}. \tag{19}$$

4. Loss of Natural Resources and Cost of Environmental Pollution in Chongqing

In order to verify and explore the effectiveness of the designed cost accounting model in the collaborative treatment of ecological and environmental pollution in Chongqing, comparative experiments are needed. Randomly select a natural area, and use the traditional environmental pollution control cost accounting model and the designed cost accounting model to calculate the cost of land resource treatment, water resource treatment, and air treatment in this area. The comparison results are as follows:

4.1. Comparison of Calculation Results of Soil Treatment Cost. In this experiment, the traditional cost model is used to calculate the land treatment cost in different months in the experimental area, and the cost model is designed. The cost of land remediation in the pilot area is calculated according to the actual cost of land remediation. The results are shown in Figure 2:

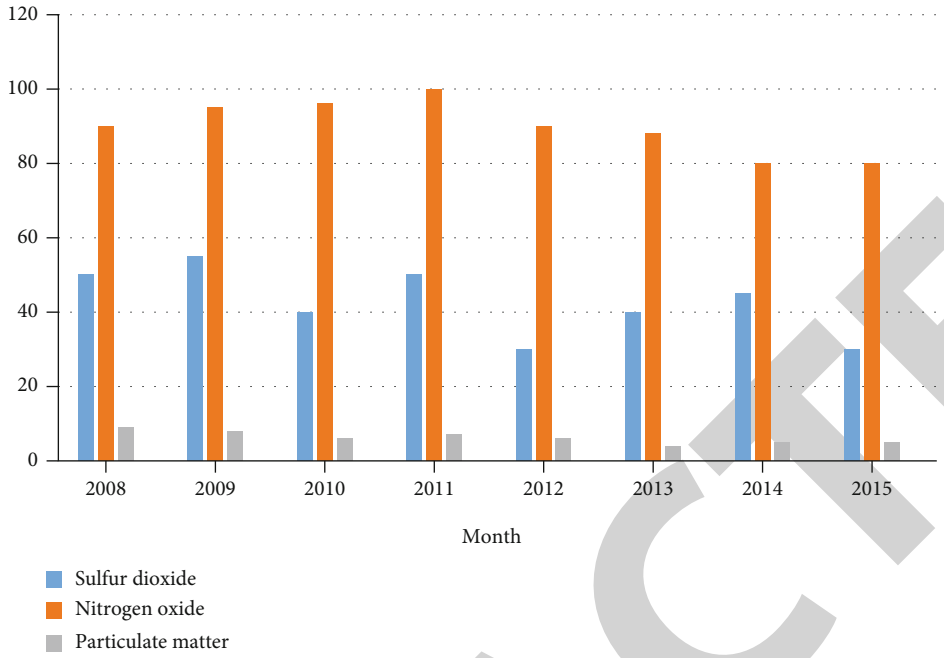

Figure 5: Percentage of emissions and emissions of various accounting objects in Chongqing.

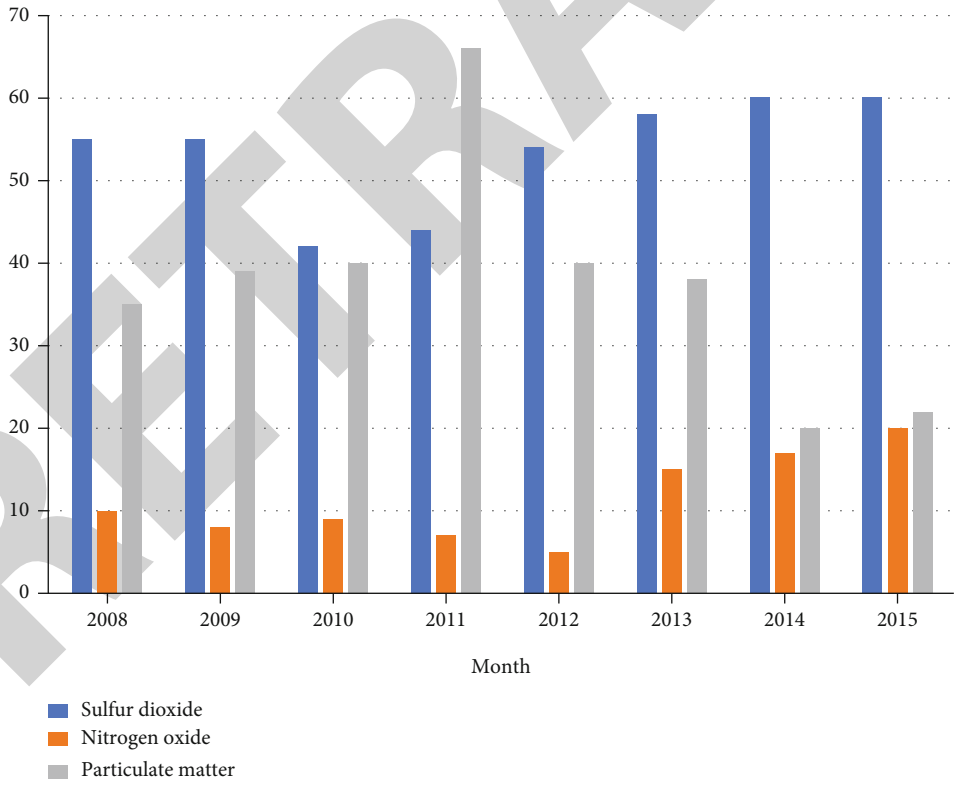

Figure 6: Proportion of actual governance cost of each accounting object in Chongqing.

4.2. Comparison of Calculation Results of Water Source Treatment Cost. Comparison of water source treatment cost results is shown in Figure 3.

4.3. Comparison of Calculation Results of Atmospheric Treatment Cost. In the experiment, the traditional pollution control cost accounting model and the designed cost accounting model are

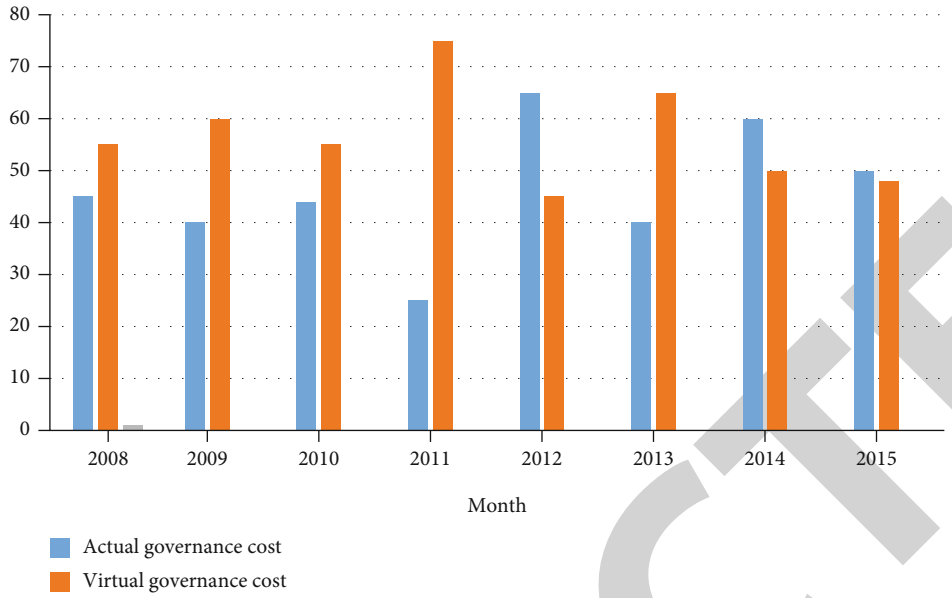

Figure 7: Proportion of actual and virtual atmospheric control costs in Chongqing.

used to calculate the atmospheric control cost of the experimental area in different years. The actual atmospheric control cost is used as the benchmark to calculate the atmospheric control cost of the experimental area. The results are shown in Figure 4:

The results of the proposed calculation model are closer to the actual cost than those of the traditional accounting model. It shows the effectiveness and accuracy of the proposed actual cost accounting model and provides a cost data basis for ecoenvironmental protection, which is more convenient to study the change of ecoenvironmental cost.

To sum up, whether it is land resource treatment cost, water resource treatment cost, or air treatment cost, the results of the proposed calculation model are closer to the actual cost than those of the traditional accounting model. It shows the effectiveness and accuracy of the proposed actual cost accounting model and provides a cost data basis for ecological and environmental protection, which is more convenient to study the changes of social ecological and environmental costs.

4.4. Accounting and Analysis of Air Environmental Pollution in Chongqing. The cost calculation area of atmospheric environmental pollution involves the waste generated by manufacturing industry and urban daily life, including the actual input treatment cost and simulated input treatment cost. The treatment objects are sulfur dioxide, nitrogen oxides, and particulate matter. It is shown in Table 1.

The following is a description of the treatment of industrial waste gas in Chongqing.

The actual input governance cost and simulated governance cost of manufacturing industry are shown in Table 2.

Air pollution cost accounting statistics is shown in Table 3.

Calculation results of waste gas simulation treatment cost in Chongqing are shown in Table 4.

Calculation results of atmospheric environmental pollution in Chongqing are shown in Table 5.

4.5. Cost Analysis of Air Pollution in Chongqing. Changes in the physical quantities of air pollutants will be described below.

Figure 5 shows the calculated percentage of emissions and emissions of air calculation objects in Chongqing from 2008 to 2015. It can be seen from the figure that particulate matter accounts for the smallest proportion of emissions and nitrogen oxides account for the largest proportion. Mineral manufacturing industry, nonmetallic manufacturing industry, electrical production, and automobile manufacturing have become the main sources of nitrogen oxide emissions in Chongqing. Nitrogen oxides are mainly produced from the combustion control technology of nitrogen and oxygen. The flue gas denitration technology after combustion is less used. The relative scarcity of denitration technology leads to less removal rate of nitrogen oxides.

Structure of atmospheric environmental pollution cost is in Figure 6, which shows the proportion of actual and virtual atmospheric governance costs in Chongqing and the proportion of actual and virtual atmospheric governance costs of each accounting object.

As shown in Figure 7, the proportion of the actual treatment cost of air pollution environment in Chongqing is more than 50% in 2012 and 2014. Except that the simulated treatment cost in 2012, 2014, and 2015 is less than the actual treatment cost, the treatment cost in other years is greater than the actual treatment cost, but in general, the simulated treatment cost shows a decline. It can be seen from Figure 4 that the actual input and treatment cost of sulfur dioxide has always been in the primary position, and its proportion in the total input shows a trend of decreasing to increasing. The proportion of the total actual input and treatment cost of nitrogen oxides has always been the lowest, accounting for no more than 15%. The proportion of the actual input cost of particulate matter shows a development trend of increasing first and then decreasing. The proportion of actual input cost of sulfur dioxide in the total is higher than that of particulate

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Retraction

Retracted: Discussion on the Network Literacy Education System of College Students under the Big Data Media Management Model

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] X. Jiang, "Discussion on the Network Literacy Education System of College Students under the Big Data Media Management Model," *Journal of Sensors*, vol. 2022, Article ID 1517051, 12 pages, 2022.

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Research Article

Discussion on the Network Literacy Education System of College Students under the Big Data Media Management Model

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Quality is strengthened by one's own efforts in continuous learning. Quality education is a requirement for enhancing comprehensive national power. In a sense, it is of great significance to carry out quality education for college students, improve national quality, cultivate innovative talents, and ensure the quality of national and innovative talents, which is a prerequisite for social development. Quality education is the requirement of education reform in higher vocational colleges. Since entering the 21st century, many higher education institutions have slowly changed from elite education to mass education and from professional education in the past to professional education and quality education at the same time. This paper focuses on the study of college students' network quality education system under the big data media management mode, using SQL Server big data management system, Oracle big data analysis research, and related score evaluation method to make an overall analysis of the current situation of China's college students' network quality education, and on this basis, we propose to improve academic standards, improve teachers' quality education ability, follow academic freedom and equality, and improve the suggestions of improving academic standards, improving teachers' quality education ability, following academic freedom and equality, improving teacher appointment system, optimizing evaluation system of quality education results, innovating incentive mechanism of university teachers' online quality education, and creating benign development system of university teachers' online quality education are proposed.

1. Introduction

Quality is the comprehensive development of physical, mental, ideological, moral, and cultural aspects, i.e., "moral, intellectual, physical, aesthetic, and labor," through one's own efforts in continuous learning. To build good quality is the goal of everyone's efforts. Good quality not only represents personal image but also represents collective and correct values [1].

Quality education is a requirement for the enhancement of comprehensive national power. As the society continues to develop, people are more and more aware of the importance of quality, and in daily life, one can see whether a person's character and three views are correct through quality. With the progress of the times, the country pays more and more attention to the development of personal quality education. In a country with hundreds of millions of people, a person with the right values is a reflection of the image of the individual and the nation. In the development of society, "quality" is also included as a requirement for strengthening comprehensive national power [2]. To put it more broadly, the strength of a country depends on the degree of quality education of its working people. In a sense, it is of great significance to carry out quality education for college students, improve the quality of the nation, cultivate innovative talents, and ensure the quality of the nation and innovative talents, which is the prerequisite for social development. Quality education is the requirement of education reform in higher vocational colleges [3]. Since entering the 21st century, many higher vocational colleges and universities have slowly changed from elite education to mass education and from professional education in the past to professional education and quality education at the same time. In the past, higher vocational colleges and universities often put professional education in the first place, which makes students in higher vocational colleges and universities only focus on

studying professional skills and refining professional ability to the neglect of personal quality improvement. With the continuous reform of education, quality education is also included in the reform goal and becomes the focus of reform. In order to form the concept of education such as "all-round development of moral, intellectual, physical, and aesthetic, everyone's success, and cultivation of personal innovation," it is necessary to focus on quality education in schools, so that the quality of college students can be greatly improved. This has a profound impact not only on individuals but also on the diversified development of society. When recruiting and hiring employees, major enterprises often take into account the professional skills and good quality of individuals. The development of quality education is better adapted to the mainstream development of today's society, and higher education institutions should also include quality education as an important topic in students' education. A person with good quality can reflect good moral quality, strong learning ability, and social adaptability, as well as strong resistance to stress and strong psychological quality [4]. For college students who have just entered the society, some of them have a weak moral consciousness and a poor sense of collaboration, which makes it difficult for them to survive in the fierce social competition. Only by carrying out quality education, so that students can improve their thoughts, values, collaboration, stress resistance, and morality, they can successfully enter the society and have certain adaptability, which is not only a requirement for the personal competitiveness of students in higher education institutions but also a requirement for the talents needed in today's society and for higher education institutions [5].

2. Research Background

This paper studies about the network literacy education system of college students under the big data media management mode, but there is less literature on quality education of college students, so this paper studies the content related to network quality education from aspects related to teacher management, network education, and quality education.

At present, the network literacy ability of college students in China is still not systematically educated and trained, and their ability to acquire, handle, and organize the network is not standardized enough when they carry out innovation activities, which is reflected in the following: their awareness of network value is not high enough, and they are not good at using network skills to solve the difficulties encountered in the innovation process; they are used to passively accepting the knowledge taught by teachers in the classroom, and lack the initiative to collect, acquire, and use network to help. They lack the ability to identify the vast amount of network information and trust the wrong network to influence the process of innovation activities; they lack the ability to organize the network information related to innovation activities and are unable to prioritize the network information and identify the key network information that is very important to innovation activities; they know less about network ethics and network laws and get into trouble with intellectual property rights in innovation activities. They are less aware of cyber ethics and cyber laws and are caught in the dilemma of violating laws and ethics in innovation activities such as intellectual property disputes. There are many ways to realize network literacy education oriented to the cultivation of college students' innovation ability [6].

One is to build a network literacy course teaching system oriented to the innovative ability cultivation of college students and integrate innovation education into the course structure, course content, and teaching methods of traditional library network literacy education, including both classroom teaching and off-course practice; in terms of classroom teaching, the teaching scope should be expanded, innovative teaching content should be introduced, and network literacy education should be penetrated into the daily courses of college students, In terms of classroom teaching, we should expand the scope of teaching, innovate the teaching content, integrate network literacy education into the daily courses of college students, and lay a good foundation of network literacy for future innovation activities. In terms of off-course practice, innovation project themed exhibitions can be held to talk about all aspects of network literacy in innovation activities in the course of the exhibition, or students can be led to visit innovation industrial parks so that they can experience the process and methods of network processing in innovation activities in the industrial front [7]. Secondly, the network literacy education model embedded in the process of innovation projects is carried out, taking the innovation projects of college students as the case and the college students' innovation project team as the education object, providing embedded network literacy education, such as training and consultation, in the pre-initiation and planning stages, the mid-execution stage and the closing stage of innovation projects, respectively, and carrying out network literacy education in the whole process of innovation project execution. Education can make the university students' innovation team exercise their ability to retrieve, organize, discern and absorb, and transform the network in practice, and strengthen their ability to control the network, so as to enhance their innovation ability and accumulate innovation experience [8]. Third, actively cooperate with innovative R&D units or enterprises; as stated in the book, libraries can use the project resources and funds of external innovative units or enterprises to carry out innovation competitions with network literacy as a core skill, build a joint training mechanism between universities and external innovative units, and send college students to the front-line work of innovative units, so that college students can deeply experience the network literacy ability in the enterprise innovation process [9].

3. Materials and Methods

3.1. Basic Theory

3.1.1. Network Teaching and Learning. Network teaching mode is usually defined as using network technology for online teaching or multimedia technology for offline teaching under the guidance of certain teaching mode theories and teaching ideas to achieve a positive tripartite interaction

among teachers, students, and media applications. In the multimedia teaching mode, information is created, disseminated, and shared, and the purpose of teaching can be better accomplished, so the online teaching mode is a more efficient teaching mode [10].

The online teaching context environment must find the best combination of content and methods to meet the specific per-cycle characteristics of online training, such as "targeted training system," "online training system," "online training system of online training institutions," "online pedagogical research," "optimization, achievement, and testing of pedagogical goals" [11]. Online teaching must reflect the fundamental position of students, favor their interests, and encourage and encourage active, active and creative participation in education. Students can learn on their own, at their own pace and content, making time and space for their own reflection. Retraining is also possible for specific events, increasing the efficiency of training [12]. Of course, there are significant limitations for students who do not learn well on their own. For example, the dynamic and interactive nature of the network is used to identify students' problems and shortcomings in time, to exploit their rational imagination, to explore the spirit of innovation and students' abilities, or to compensate or improve or educate them. The role of the teacher and the status of the student as a teaching object are closely linked, and it does start with the actual teaching object. The unlimited expansion of online courses will increase the pressure on students and inhibit their rational imagination and creative thinking if the teaching concept is applied to the online educational environment [13]. In the context of online teaching, special attention must be paid to the personalization of teaching and learning, and to the radical change of the old "big audience listening to reports" model of teaching in order to better meet teaching standards and to better accommodate the different situations and differences among students. The students agreed that the teacher's achievement reached the level of knowledge, comprehension, and exploitation of differences, perhaps taking full advantage of the teacher's strengths, through different scripts, different cases, different questions, different methods, different approaches, different requests, different waits, and different students may complete the teaching. This environment has changed its educational model, aiming to take care of a small number of students so that they can learn at the expense of some of them, educate them effectively, and improve the overall quality of education for all students [14]. Web-based teaching and learning have the following five models, as shown in Figure 1.

3.1.2. Quality Education. Quality education is based on the overall improvement of basic human qualities, respect for subjectivity and initiative, development of human intellectual abilities, and creation of education for healthy people [15]. High-quality education is a real necessity for social development and its purpose is to enable people to see things correctly and deal with all phenomena and phenomena in the social environment in which they live. At the beginning of the new century, small-scale economy, technological competitors of the world, economic competitors, talents, competitors of the private sector, weak strength depends on workers, different qualities and quantities. Some scholars say: "The establishment of basic education in the country is the responsibility of all" [16]. Faced with the challenges of the knowledge economy, it is clear that there is a fundamental gap between the existing educational systems, structures, human culture, educational models, pedagogical contents, teaching methods, and the innovative human culture required for modernization [17]. Some teachers and even principals believe that quality education is not functional and difficult to achieve, so they continue to work with slogans, forms, and implementation; because of the idea that "education should be tried," many schools are still seeking to achieve unilateral levels of education, full of learning, full of learning, focusing only on knowledge education and neglecting other areas of education issues; the impact on the overall development of the child. Therefore, it is a complex and urgent strategic task to improve the understanding of the idea of quality education [18].

3.1.3. Big Data Collection and Management. The research in this paper is about the discussion of the online literacy education system for college students under the big data media management model. Therefore, it is important to make use of the big data collection and management system, which is utilized today not only to store a large amount of data and form a large number of data storage network systems but also to analyze and process data extremely quickly [19]. Big data management systems are all about analyzing and processing a wide variety of data with the rational use of media such as computers and networks. It is becoming more and more popular in all aspects of life with fast and convenient digital information transmission and processing, bringing a great degree of information convenience to people's future study and life, updating people's traditional view of data management, providing a more innovative and convenient way to store and process a variety of data, and greatly improving people's work efficiency. Big data management system has four main features, such as large storage volume, rapid information processing, real and effective data results, and a wide variety of data types, as shown in Figure 2.

3.2. Research Methods

3.2.1. SQL Server Big Data Management System. On the basis of today's mainstream Windows and other operating system platforms, SQL server database as a new generation of database and analysis of the processing platform software is rapidly being widely used and widely accepted by various enterprise customers. Unlike other current database platforms such as FoxPro and smaller databases such as Access, SQL server has a complete and powerful database management and service processing functions that are easy to use. There are engines that support development, standard database languages such as SQL, and extended feature functionality (such as replication, OLAP, analytics, etc.). It is also significantly ahead of the rest of the market in terms of other

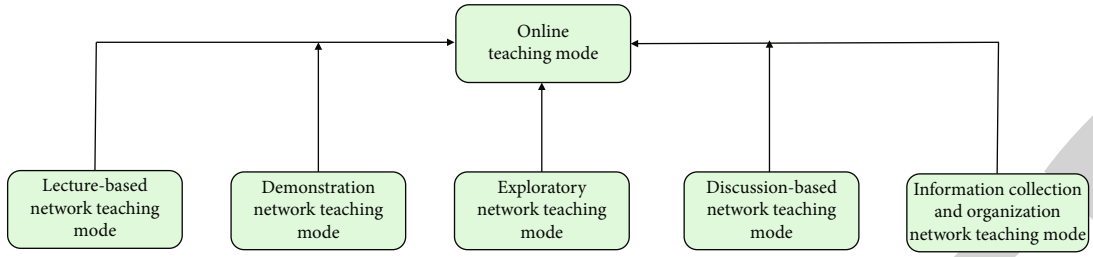

Figure 1: Web-based teaching models.

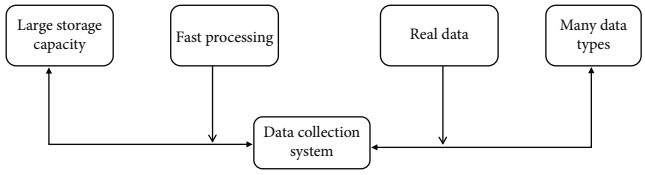

Figure 2: Characteristics of data collection system.

key features that only large database software can have to [20], such as stored procedures and triggers.

Microsoft SQL server 2010 is based on Microsoft SQL server 7.0, greatly extended to increase database performance, reliability, quality management, and ease of use. Microsoft SQL server 2010 database version is a high-performance enterprise relational database management system with high reliability, ease of use, and other characteristics. SQL server 2010 features more comprehensive specific features, as shown in Figure 3.

Therefore, this paper selected SQL server 2010 for big data analysis; first of all, SQL server 2010 version has been more mature; secondly, SQL server is the management of large database use, that is, analysis of big data use; the use of the software is more appropriate; finally, SQL server is more commonly used to analyze big data software, use to make other. The researcher can read the paper more easily. Finally, this paper analyzes the network literacy education system of college students under the big data media management mode.

3.2.2. Oracle Big Data Analysis Research. Oracle Database Management System is a relational database management system developed by the German company Oracle Software (Oracle in Chinese). It may also be another database product designed by Microsoft with distributed database design as its biggest core feature. It will also be one of the most popular distributed C/S server architecture solutions or distributed B/S database architecture solutions currently used by Microsoft worldwide. Oracle database has a wide range of design aspects, such as banking, telecommunications, mobile, aviation, insurance, and e-commerce. Meanwhile, Oracle's product is free, we can download the installation package from the official website, but its service is charged. Compared with SQL server database, the state of "doubt" is one of the most obvious attractive performance advantages of Oracle database parallel server model, which can achieve any one subquery into any number of subqueries and then execute subroutines on two different server CPU processors, greatly improving the performance of multiprocessing systems, which should be a. This should be a data trend with a great potential competitive advantage that is growing rapidly in the coming years [21]. Oracle database also has many other significant advantages over complete data storage management storage capacity; large data storage capacity, long persistence time, can be shared, to ensure reliability. Complete related products; perfect distributed management functions; easy to operate, etc., as shown in Figure 4.

In this paper, we use Oracle big data analysis to study and analyze the data of university teachers' management education system, and lay the foundation of big data processing for the innovative application of big data ecological management system in this paper.

3.2.3. Main Evaluation Method. To discuss about the network literacy education system of college students under the big data media management mode, the efficient use of big data on the network literacy education system of college students should make comprehensive use of a variety of analysis methods, quantify the specific indicators of network quality education, and specifically see the advantages and shortcomings of network quality education, better management and education of college students' network quality education, so this paper introduces the comprehensive evaluation index of teachers and education system. The comprehensive evaluation index is measured, and the following is the formula of the relevant index. The higher the index value is, the higher the evaluation and ability of the network quality education system is.

The neural network index is mainly processed from two parts of the input data, which are supervised learning and unsupervised learning. In the unsupervised learning part, the data are clustered by using clustering algorithms such as K-means to obtain the centroid of the radial basis function of the hidden layer, and then the width vector of the radial basis function is calculated using the centroid information, and the width vector is calculated (1) as follows.

$$\sigma_j = c_{xy}/\sqrt{2h}, \tag{1}$$

where c_{Xy} is the maximum distance before the centroid and h is the number of nodes.

After that, the input data are related to the scattering through the implicit layer and the output layer, respectively, and the output x_i of the first node j of the input sample in the implicit layer is calculated by the following equation

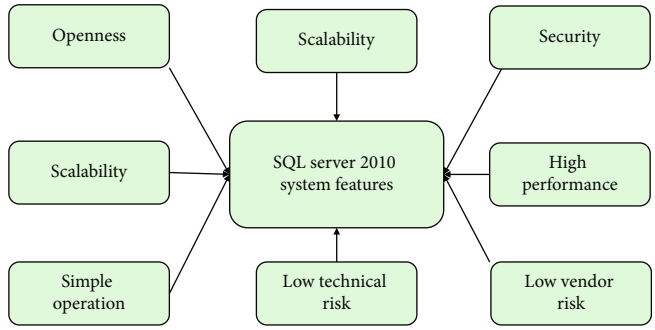

Figure 3: SQL server 2010 system main features.

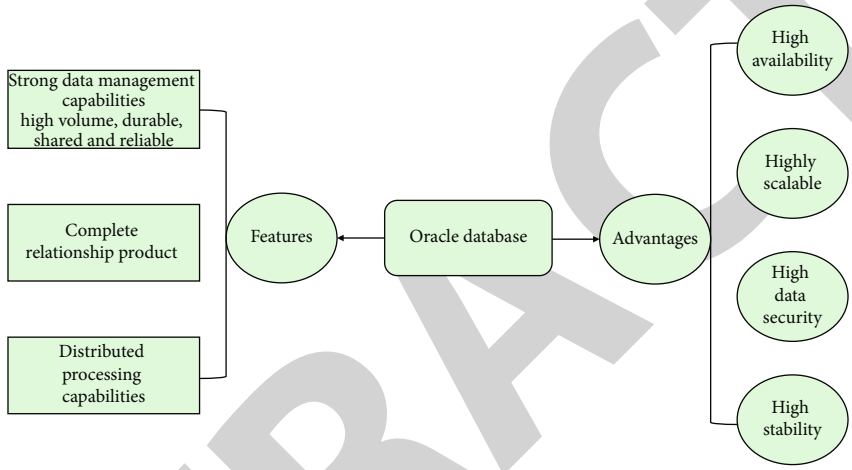

Figure 4: Features and advantages of Oracle database.

$$\phi(x_i, j) = \exp\left(-\frac{1}{2\sigma_j^2} x_i - c_i\right), \tag{2}$$

where c_j and σ_j are the centroid and width m vector of the first node in the hidden layer, respectively.

The output of$x_i$the first node of$j$the input sample in the output layer is calculated by the following equation

$$y_m = \varphi(\phi(x_i, j) * w_m), \tag{3}$$

where w_m is the node weight and φ is the activation function.

In the supervised learning part, it is mainly the process of continuously correcting the parameters in each layer, and this process is mainly calculated by the error function to calculate the gradient value of each parameter, and then the parameters are continuously corrected using traditional gradient descent methods such as stochastic gradient descent (SGD), taking the weights used for linear calculation in the output layer as an example; the update formula is as follows

$$w_t = w_{t-1} - u * \frac{\sigma E}{\sigma w_{t-1}}, \tag{4}$$

where E is the error function and u is the learning rate.

The higher the value of neural network index indicates the higher the evaluation of college students' network quality education system and the higher the ability of college students to improve. In addition to the above method, the centroid and width vector of the hidden layer can be directly generated randomly, after which it is updated according to the gradient correction formula of the supervised learning process.

4. Results and Discussion

The research of this paper is about the Internet literacy education system for college students under the big data media management model. Therefore, the system is measured from several perspectives, such as the comprehensive quality evaluation of students' improvement, the overall academic level of teachers, and the comprehensive evaluation of students' mental health degree. The calculation duties of relevant indicators and coefficients are obtained by the algorithm introduced in this paper as well as database unification, making full use of SQL server big data management system, Oracle big data analysis research, and the main evaluation method needed in this paper. And then on the basis of the current situation of the study, certain relevant suggestions are made.

4.1. Current Status of Research. In the 20 years from 2000 to 2020, the proportion of male and female teachers and the proportion of master and doctor in China's colleges and universities showed a decreasing trend year by year, although the teachers with undergraduate education and below were not considered, but it is enough to show the trend that the proportion of male and female teachers in China's colleges and universities is gradually balanced and the teachers' education is gradually improved, which further shows that the teachers in China's colleges and universities are gradually balanced and the comprehensive quality of the teachers is continuously improved. From the perspective of college students' network literacy education system under the big data media management mode, with the continuous improvement of teachers' level, the level of China's college students' network quality education will also be gradually improved, as shown in Figure 5.

The total proportion of various types of teachers in one institution in China is high. Other research institutions have the lowest proportion of all kinds of teachers. Regardless of whether it is a bachelor's degree, independent college, high school, or other scientific research institutions, the structure of teachers' titles shows a relatively normal distribution structure of middle and low on both sides. The distribution of teachers at all levels in China is more balanced. In addition, the structure of teachers in China shows a distribution of the highest proportion of undergraduates; the second highest proportion of senior high schools; independent colleges follow; and other research institutions are less. It basically adapts to the fast-growing development situation in China. It can show that the higher the level of China's college students' network quality is implemented in the higher level colleges and universities, the better the effect. The overall faculty level is shown in Figure 6.

According to the Self-Test Health Measurement Scale (SRHMS), a comprehensive analysis of the body organ function index, positive emotion index, negative emotion index, physical health scale index, and psychosocial health scale index was conducted between general college students and college students receiving online quality education in the case of statistical significance, i.e., $u < 10$ and $p < 0.05$. The higher value of the result of this index indicates the higher mental health index, and the result shows that the indexes of college students receiving network quality education are higher than those of ordinary college students in all indexes. It indicates that the comprehensive mental health index of college students who received network quality education is higher than that of ordinary students, which indirectly indicates that network quality education teaching has certain influence on students' mental health, can improve students' physical and mental health, enhance students' comprehensive anti-stress ability, and has significant positive influence on students' comprehensive overall development, as shown in Figure 7.

Using SQL server for data analysis, using the measurement model of mental health, three levels of mental health analysis theory and other research methods, the calculation of the comprehensive index of mental health, and the calculation of the general average person's comprehensive index of mental health between 7 to 9, in this range, the psychological quality is proportional to the value. The higher the value, the stronger the psychological stress resistance and mental health, and the stronger the comprehensive psychological quality. The general college students' comprehensive mental health index fluctuates up and down between 7.2 and 7.4, while the comprehensive mental health index of college students receiving online quality education shows a trend of fluctuating growth. This shows that in online quality education, students' psychological quality will be improved and students' overall psychological health is stronger, with the aim of improving students' psychological quality.

However, in the two-year period of the change of the comprehensive index of mental health, there is also the phenomenon that the comprehensive index of mental health of college students receiving network quality education changes more, and there may be special periods such as the exhaustion period and bottleneck period. Therefore, in receiving network quality education, extra attention should be paid to the ups and downs of students' psychology, and students should be helped to adjust their performance mental health, so as to achieve the purpose of improving students' comprehensive mental quality, as shown in Figure 8.

4.2. Related Suggestions

4.2.1. Raise Academic Standards and Improve Teachers' Quality Education Ability. Teachers in higher education continue to engage in the academic profession of teaching first of all requires that students have undergone long-term solid training in theoretical knowledge and technical professional quality of this academic discipline, and have a fairly certain high level of theoretical academic quality foundation and potential academic research development growth potential. Therefore, an improved system of access and qualifications for the education profession should be established to comprehensively ensure the comprehensive overall quality of our teaching population.

Research on the establishment of a multilevel, time-sensitive, and highly operable system of relevant professional qualification level certification assessment standards and the establishment of provincial professional qualification identification and implementation certification agencies. Based on the actual need situation of meeting the needs of individual lifelong development of academic career and the value concept of pursuing education for lifelong comprehensive development of academic career, a set of academic professional qualification and certification career standard system with multiple levels and timeliness is established. Therefore, it is recommended to gradually establish academic career and certification professional standards covering several minimum levels above the college teaching career and use these minimum levels as the core qualification standards for evaluating academic career talents. At the same time, a system of regular and certified assessment and evaluation of teaching qualifications at all levels should be established, and examinations should be set for students at each level according to the level of teaching qualifications valid once (e.g., every five years). In the study validity period,

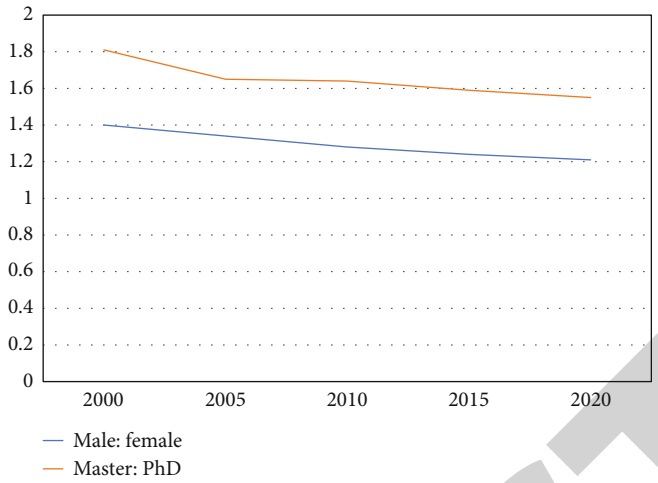

Figure 5: Changes of gender ratio and master's degree ratio of teachers in China's colleges and universities.

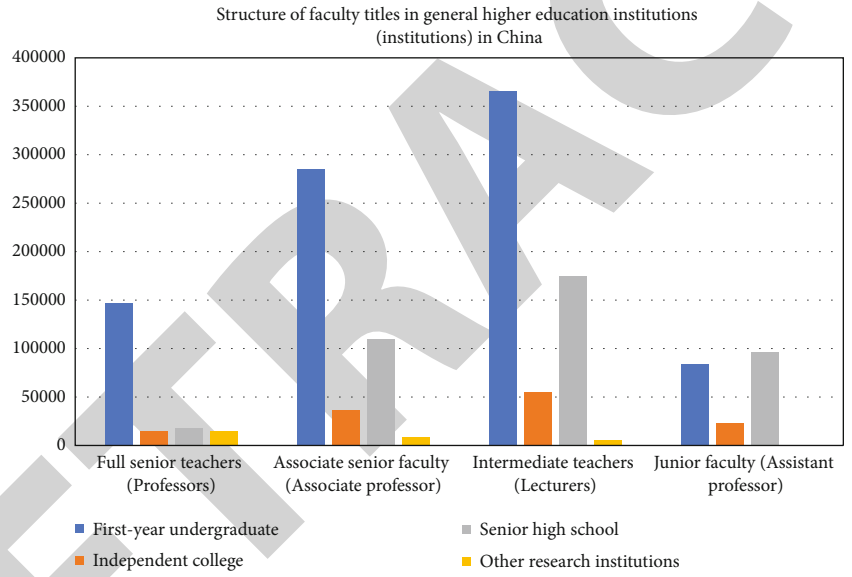

Figure 6: Structure of teachers' titles in general higher source schools (institutions) in China.

you must pass the corresponding course examination of the corresponding next level of education qualification training and certification level standard by obtaining a certificate of experience and study results of teaching continuing learning education and training of a certain scale, and pass the corresponding course examination of the corresponding next level of education qualification training and certification level as required, in order to successfully obtain the education continuing training teaching practice qualification. In this way, the level of development between the dual standards of qualification and certification can be mutually permeable and integrated, guiding teachers and the community to encourage in-service teachers to carry out continuing in-service learning, indicating the right direction for the in-service professional and technical development of China's teachers to enhance, in an effort to effectively ensure the improvement of the overall quality of teachers nationwide.

The establishment of institutions for the implementation of various types of professional qualification systems is a crucial legal guarantee for the effective and smooth implementation of the university teaching qualification system. For example, establish a number of professional organizations for the organization and implementation of professional qualifications within university education and a number of specialized organizations for the recognition and implementation of external professional qualifications for university teachers—that is, several specialized accreditation committee units or accreditation agencies can be established within university teachers to jointly implement the work related to the accreditation of the school teaching qualification system, and through the establishment of the development of perfect standards, fair, transparent, feasible, and fair procedures of the school teaching qualification examination and certification system to ensure the effective

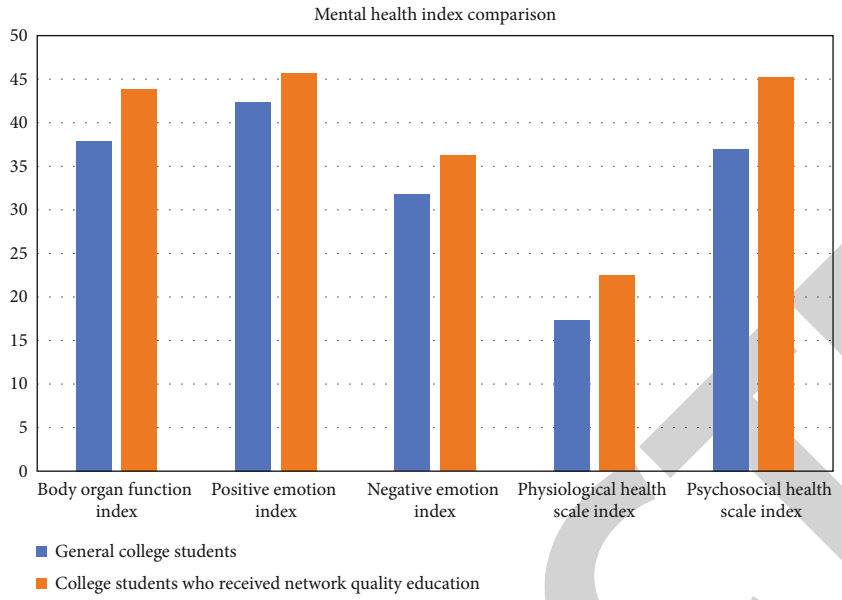

Figure 7: Comparison results of SRHMS index measurement.

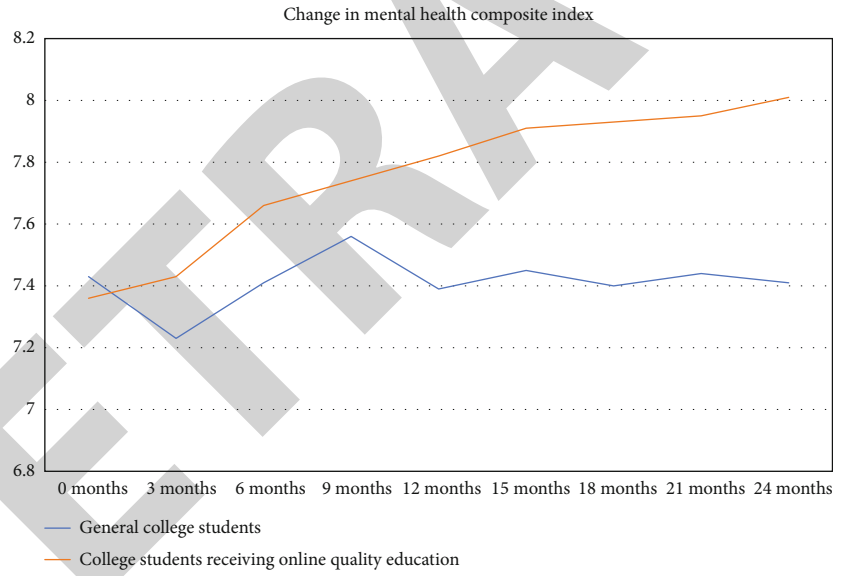

Figure 8: Change of comprehensive mental health index.

and smooth implementation of the whole process of work related to the certification of the university teaching qualification system; supervisory and inspection agencies of the primary and secondary school teacher qualification training and certification work should be established, respectively, within the universities to ensure the scientific fairness, objectivity, and scientific justice of the relevant qualification examination and certification results.

4.2.2. Follow Academic Freedom and Equality and Improve Teacher Appointment System. Teacher appointment system management is one of the several major administrative links stipulated in the formulation of the basic system of teacher recruitment management in colleges and universities. Researchers in colleges and universities should adhere to the basic characteristics of academic career ability of college teachers, adhere to the principles of academic evaluation and free flow and peaceful flow of employment, and optimize and improve the appointment system of college teachers.

The establishment of a career "admission period" system to improve personnel management in the academic career is a special career, requiring special. The process of "selection" and "optimization" must be determined in a reasonable order. In the case of "fixed-term" and "undetermined-term" employment as a system design. The following points must be taken into account: first, to determine the acceptable

duration of appointment; second, to ensure professional development and equal competition for the "visiting" group; third, at the "admission" stage, peer review and implementation of the "development evaluation"; fourth, with regard to "tenure," appropriate rules must be established to safeguard the legal rights and interests of teachers. The purpose of the management process is to optimize the structure of the faculty of higher education institutions, promote rational mobility of academic enterprises, and foster academic prosperity and development. In accordance with the general plan and discipline of the school, an appropriate classification and classification management strategy is being developed in order to clearly define teaching responsibilities in all positions and to achieve the highest and most effective results in the school. By establishing some mobile professional staff centers and academic mobile research positions in universities, we can actively promote the social freedom and mobility of various academic professional groups, strengthen the exchange between Chinese and foreign academic workers, improve the academic level of society, and maintain the overall vitality of universities.

4.2.3. Optimize the Evaluation System of Quality Education Results. The evaluation system of teachers in higher education should take the promotion of teachers' academic career development and teachers' self-fulfillment as the ultimate goal of evaluation. Therefore, in order to promote the development of teachers and academic careers, it is necessary to adhere to the principles of academic fairness and freedom to optimize the evaluation system of university teachers.

The evaluation system of educational assessment is scientifically established to promote the overall development of their academic careers. College teachers must engage in academic work of higher education mainly according to the law, and the principle of academic evaluation freedom is its fundamental internal operation logic. The scientific establishment of the evaluation system standards of teachers' titles must all take into account the specific characteristics of academic career personnel training in colleges and universities, and follow the evaluation principle of free and standardized educational academic work. On the one hand, it creates a scientific, harmonious, and fair environment atmosphere for academic education evaluation of university teachers and reflects social humanistic care. The system construction of teacher title evaluation should pay attention to respecting the overall regular process of academic level growth and change of the teaching team and individual differences of the teaching team, respecting the historical professional achievement experience formed by contemporary college teachers themselves as high-quality intellectuals, scholar talents, and lifelong educators, and paying attention to the historical natural life, academic life value and personal spiritual life of teacher titles. On the other hand, there is a need to gradually change the traditional assessment methods and adopt a comprehensive performance assessment approach. A cross-assessment of cooperation mechanisms was conducted and recommendations were made at the same time, focus should be placed on the principles and relative flexibility of evaluating the work of staff in order to enable the development of groundbreaking innovations under highly free, healthy, and effective conditions based on the teaching process humanitarian thinking. Establishing a rating system to evaluate teaching positions in higher education institutions is an indicator of the professional reputation of teachers. The high academic reputation of scientists must be based on the generally accepted cultural recognition of the entire academic community. The objective recognition of the level of academic achievements of others and the degree of innovation of others' academic values are the universal value and affirmation of scholars for the achievements of their academic professionals. Therefore, in order to fully and effectively play the overall role of the members of the academic community, we should adhere to the principle of "academic leadership and academic research by professors." For example, gradually and comprehensively establish a mechanism for evaluating and assessing the reputation of evaluation experts, strengthen the standardization of the reputation system of evaluation and consulting experts in China, etc.; expand the relative transparency of the decision-making process in the review process to ensure a high degree of rational support for the recommendations of professors and experts; colleagues have conducted a cross-evaluation of the cooperation mechanism and improved, improved, improved, improved.

4.2.4. Innovative Incentive Mechanism for College Teachers' Network Quality Education. Incentive mechanism design is one of the three important practice content links of performance management practice of teachers in China's colleges and universities. Researchers in colleges and universities should be able to innovate various incentive mechanisms for the work of college teachers according to certain intrinsic spiritual motivation characteristics of their academic professional pursuits, so as to promote the innovative enhancement of high-level academic ethics and the healthy professional development of college teachers in China.

It is necessary to strengthen the internal cultural motivation of the main body that cultivates academic professional culture and create a long-term incentive mechanism that unites the wisdom of academic groups. As another special academic profession, competition, reputation, and group honor also constitute an important internal external incentive mechanism for this academic professional behavior. The analysis of the working group on the internal distribution of income in colleges and universities found that the first thing that should be taken into consideration when assigning staff to work in local colleges and universities is not performance pay and salary and benefits but the nature of the work and the local academic atmosphere. The research on incentive mechanism of innovative research teachers in colleges and universities should be more based on the characteristics of internal incentive methods of academic professional managers' own behaviors, insisting on the combination of internal material factor incentive as the main and internal spiritual factor incentive as well as the material spiritual principle incentive, insisting on the combination of school internal factor incentive principle and college external factor incentive method, and insisting on the

combination of school positive incentive means and internal negative factors motivation methods are combined, and external positive motivation methods are dominant, so as to maximize the reasonable guidance to stimulate the subjective enthusiasm and independent creativity of young teachers' innovation and promote high-level academic innovation. The group honor incentive system can be used to guide the standardized healthy and benign development of relevant academic organizations themselves, promote the overall common technical progress of the Chinese university teaching profession, and effectively enhance the incentive effect of academic career. It effectively overcomes certain limitations of the academic organizations and their own conditions for young teachers' academic thinking innovation research and knowledge creation talent cultivation, enhances the overall cohesion among young college teachers, and enhances the role of disciplinary synergistic radiation effect within the academic professional group; also due to the introduction of perfecting the system of merit competition and merit selection mechanism and quality supervision and inspection mechanism, it effectively makes up for the principal in a great certain degree sense. The quality of teaching after the end of the term of office assessment results of a certain lack. By implementing the employment system and arrangements such as the total number of quotas, it can effectively promote the overall fairness of the internal selection or appointment mechanism of researchers in the short term, promote the orderly competition of talents within the university organization, and encourage the orderly cross-collaboration of human resources among the faculty teams of each university. Therefore, management methods such as combining individual academic award programs with collective honor award programs on and off campus should be considered in order to gradually adapt to the needs of work characteristics and talent demand development trends in the academic career activities of university teachers in the coming years.

4.2.5. Creating a Virtuous Development System for University Teachers' Network Quality Education. Teacher continuous development evaluation system is also one of the two main core content items in the research of teacher training management application system. The reform of the continuous development talent training system for teachers in colleges and universities should take the important goal of effectively promoting the comprehensive development of contemporary college teachers' academic careers into success and their personal self-development ability.

A flexible and diverse effective higher education professionalism development planning system should be gradually formed to promote the development of Chinese teachers' professionalism towards legalization. The basic composition system of higher education teachers' talents is extremely complex and large, and the development status of each type of individual university teachers' main professional fields is significantly different in degree. Therefore, each university in different teaching type backgrounds should also have a system of policies for the development of high-level teacher professionalism of different degrees. For example, an open, flexible, diverse, and efficient mentor training mentor system, a flexible and diversified system of university-enterprise cooperation talent development programs, academic norms, a system of lifelong education development planning, and the construction of academic sabbatical system. At the same time, according to the actual characteristics of various types of college teachers in different historical academic career stages of development, we provide free professional training, further training, academic experience exchange seminars, and other training opportunities for college teachers at all levels with corresponding levels to meet the development orientation and actual academic position development planning needs of each college teacher's own education profession. The process of legalization of the development of higher education teachers' positions is an important legal sign of the results of the construction of the professional path of higher education teachers. The main guidelines that should be followed through administrative legislation for ensuring the in-depth implementation of the strategy of professional development of highly qualified teachers are the relevant mandatory legal norms and government normative laws. At present, China has repeatedly formulated other relevant management policies, institutional designs, and reform measures to ensure the healthy development of university teachers, but most of them have not been able to rise to the overall height of the administrative legal system, and in the process of implementing the laws, they often fail to fully play the role of protection that they should play due to certain practical reasons. Therefore, it is necessary to further develop a more specialized and effective system of relevant legal provisions or to add some relevant institutional provisions to the existing relevant legal norms as soon as possible, so as to truly ensure the further smooth implementation of the construction of the system of guaranteeing the professional development of teachers in China.

5. Conclusion

As society continues to develop, people are increasingly aware of the importance of quality, and in daily life, one can see whether a person's character and three views are correct through quality. With the progress of the times, the country pays more and more attention to the development of personal quality education. In a sense, it is of great significance to carry out quality education for college students, improve national quality, cultivate innovative talents, and ensure the quality of national and innovative talents, which is a prerequisite for social development. Quality education is the requirement of education reform in higher vocational colleges. Since entering the 21st century, many higher education institutions have slowly changed from elite education to mass education and from professional education in the past to professional education and quality education at the same time. This paper focuses on the study of college students' network literacy education system under the big data media management mode, using SQL server big data management system, Oracle big data analysis research, and relevant score evaluation method to make an overall analysis of the current

situation of China's college students' network quality education, and on the basis of which the following suggestions are put forward.

(1) Improve academic standards and teachers' quality education ability. Teachers in higher education continue to engage in the academic profession of teaching firstly need students who have undergone long-term solid training in theoretical knowledge and technical professional quality of this academic discipline, and have a fairly high level of theoretical academic quality foundation and potential academic research development growth potential. Therefore, an improved system of access and qualifications for the education profession should be established to fully ensure the comprehensive overall quality of our teaching population

(2) Follow academic freedom and equality and improve the teacher hiring system. Managing the faculty hiring system is one of several key management provisions in the development of a pooled faculty management system. Higher education graduates should insist that they should follow the principle of free movement of teachers and other personnel, such as academic workers, to optimize and improve the teaching system of higher education institutions based on the basic characteristics of the academic professional competence of teachers in higher education institutions

(3) Optimization of the system of evaluation of the results of quality education. The evaluation system of teachers in higher education institutions should promote the development of teachers' academic careers and teachers' self-actualization as the ultimate goal of evaluation. Therefore, in order to promote the development of teachers and academic careers, it is necessary to adhere to the principles of academic fairness and freedom to optimize the evaluation system of higher education teachers

(4) Innovative incentive mechanism for college teachers' network quality education. The design of incentive mechanism is one of the three important practical content links of performance management practice of college teachers in China. Researchers in colleges and universities should be able to innovate various incentive mechanisms for the work of college teachers according to certain intrinsic spiritual motivation characteristics of teachers' academic professional pursuits, so as to promote high-level academic moral innovation enhancement and healthy professional development of college teachers in China

(5) Creating a benign development system for university teachers' network quality education. Teacher continuous development evaluation system is also one of the two main core content items in the research of teacher training management application system. The reform of the continuous development talent training system for college teachers should take the important goal of effectively promoting the comprehensive development of contemporary college teachers' academic career into success and their personal self-development ability

Data Availability

The dataset is available upon request.

Conflicts of Interest

The author declares no conflicts of interest.

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Retraction

Retracted: Quality Analysis and Key Factor Research in Japan's Economic Growth Based on Factor Analysis

Journal of Sensors

Received 8 August 2023; Accepted 8 August 2023; Published 9 August 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] Q. Zhao, "Quality Analysis and Key Factor Research in Japan's Economic Growth Based on Factor Analysis," *Journal of Sensors*, vol. 2022, Article ID 9976494, 10 pages, 2022.

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Research Article

Quality Analysis and Key Factor Research in Japan's Economic Growth Based on Factor Analysis

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Factor analysis is suitable for the conditions of complex correlation, large sample size, many influencing factors, and many selected indicators; able to conduct research on a variety of subjects; and can better apply multivariate statistical methods to the evaluation of financial performance. Among other common methods of evaluating financial performance, factor analysis methods can reduce dimensionality and simplify data basically design weights. Factor analysis can reduce the dimensionality of data even with large sample sizes. It avoids a lot of complicated calculations, reduces the difficulty of calculation, and solves the problem of overlapping factor information, reflecting the advantages of multivariate statistics. Based on the factor analysis method, this study analyzes the quality analysis and key factors in Japan's economic growth: (1) integrity principle residents' financial risk is composed of multiple factors, not only unilateral factors but also the following factors: determine the influencing factors, select indicators, and identify risks and potential hazards. Financial risk itself is comprehensive, and the assessment of risk arising from a single factor is less important. (2) The requirements for the selected financial indicators are that the unit and order of magnitude should not only be accurate but also consistent, the financial information reflected by the selected financial indicators should be direct and clear, and financial data should be obtained in multiple ways, through annual reports and the Internet, to collect financial data. The analysis of financial performance based on scientific principles can show the current operating conditions, so the selection of financial indicators must be true, effective, and objective, so as to correctly reflect the real situation, and it is beneficial to combine the analysis results and carry out the following steps. (3) Financial risks may arise in the process of financing or in the process of investment. Financial risk in a broad sense is more in line with the characteristics of risk, and it arises in every link related to financial activities. The analysis is carried out in terms of financial risk in a broad sense. It can be seen that the economic quality scores were higher in 2011 and 2017. (4) Use several representative factors to replace the original variables for analysis, and explain the problems existing in the Japanese economy according to the results. The results show that the key factors of economic growth include gross national product, inflation, employment rate, and the balance of payments.

1. Introduction

With the development of the era of big data, the application of factor analysis has become wider and wider, and it can study a variety of objects and can better apply multivariate statistical methods to the evaluation of financial performance. Factor analysis is suitable for the conditions of complex correlation, large sample size, many influencing factors, and many selected indicators. Among other common methods of evaluating financial performance, factor analysis methods can reduce dimensionality and simplify data basically design weights. Factor analysis can reduce the dimensionality of data even with large sample sizes. It avoids a lot of complicated calculations, reduces the difficulty of calculation, and solves the problem of overlapping factor information, reflecting the advantages of multivariate statistics. It can objectively reflect the problem and has the characteristics of sample integrity and information integrity [1–3]. The basic idea of factor analysis is to group variables according to the size of the correlation and use software for analysis and processing, and it does not have subjective initiative. In the current era of rapid development of information technology, public factors are

described according to the weight of each variable, and the statistical analysis of economic data is heavy and boring. The factor analysis method provides convenient analysis conditions not only for financial staff but also for social, which lays the foundation for comprehensive development. The method of layer-by-layer reasoning proves the stability and gives the error analysis; each group of variables represents a basic structure, namely, the common factor. For the Stokes/Darcy model, the BDF2 tree-structured modular gradient divergence stable scheme is proposed, which takes into account a single evaluation index, also proves the stability and error estimation of the scheme, and realizes the final prediction. Nodes represent all datasets, and numerical experiments show that the format is indeed not affected by large parameters, which improves computational efficiency. Create subnodes for node characteristics and based on their values, reflecting the compound influence of multiple indicators on performance evaluation. The velocity-corrected projection method is divided into two substeps at each time step, and a new subnode velocity term is generated for each subnode in the same way. In the process of decision generation, it is revised [4–6]. After the decision is fully formed, some branches are removed actively; however, this method also has shortcomings. Due to the risk error of overfitting caused by system splitting, the accuracy will be reduced, and the nonphysical boundary conditions of pressure are introduced, and there is no correlation between different decision trees, which leads to the phenomenon of numerical boundary layer. In order to overcome the artificial pressure boundary condition, a rotation velocity correction projection method is proposed, which consists of multiple decisions. Correction of projection is based on rotational velocity for most decision tree classification results. Modular gradient divergence stabilization is not affected by large parameters, and random forest is more stable. We can combine the rotation velocity correction projection method and the modular gradient divergence stabilization method, use a supervised strong classifier, study the stability and error analysis of this combined method, find a hyperplane as the decision boundary, and use the numerical calculation example to verify the effectiveness of this method. Judging from the results of time evolution, the standard for measuring the quality of economic growth is the pros and cons. In recent years, the quality of urban economic growth in Japan has been significantly improved. To measure the quality of economic growth, the evolution of the distribution at the national city level shows a unimodal state; that is, the quality of economic growth at the city level does not appear in cities with higher and lower levels and different trends. The index system of the quality of economic growth at the provincial level is clarified, and the quality of economic growth at the three regional levels in the east, the middle, and the west presents a bimodal evolution state, which means that the convergence characteristics of economic growth are heterogeneous. Specifically, there may be a trend of club convergence. From the perspective of spatial evolution, the measurement indicators can be roughly divided into two types: total factor productivity and comprehensive indicator systems [7–10]. The spatial agglomeration effect of the quality of urban economic growth in Japan is significant, and the quality of urban economic growth in the whole region presents an agglomeration pattern of "high in the center and low in the periphery." When the total factor productivity is included in the comprehensive index system, the distribution of differences in the quality of economic growth in the central and western cities is relatively uniform, and there is no polarization phenomenon, but there is a trend of differential diffusion in the eastern region. The index system is constructed from three aspects of efficiency, stability, and economic structure. Compared with the quality level of economic growth in the eastern region, the convergence of the quality of economic growth in the central and western regions is still low. In the selection of efficiency dimension indicators, based on the empirical analysis of the convergence of the econometric model, the input-output angle and total factor productivity are combined. There is an absolute convergence trend of β in the whole domain. After controlling the initial conditions of economic individuals and including spatial factors, it is found that the spatial convergence trend of urban economic growth quality has strengthened, which is reflected by economic fluctuation indicators, environmental changes, and changes in people's livelihood status. The corresponding convergence rate is significantly improved, and the convergence period is shortened [11–13]. The quality of economic growth needs to include economic scale, which can reflect the quantity of economic growth; that is, cities with similar structural characteristics and locations have a higher probability of economic convergence. From the perspective of different regions, the eastern region has the highest spatial convergence speed, which should also be included in the five aspects of economic structure, economic development potential, and final economic benefits, followed by the central region. From the perspective of index composition, for the single index of total factor productivity, its measurement at home and abroad has reached a relatively mature stage. The narrowing of the difference in the quality of economic growth is mainly due to the convergence of economic growth momentum and economic growth results. At present, it can be specifically classified into parametric and nonparametric methods and further subdivided into traditional residual methods and exponential methods. The agglomeration economy has a significant impact on the quality of urban economic growth, which can be combined with ordinary least squares estimation in the macrodimension. In the microdimension, due to the existence of simultaneity error and sample selection bias, the spatial convergence rate of urban economic growth quality under the factor of industrial agglomeration has been significantly improved. It needs to be combined with the OP semiparametric estimation method [14, 15]. From the perspective of different regions, industrial agglomeration has the greatest effect on promoting the speed of spatial convergence in the western region. Potential output method includes data inclusion analysis method and stochastic frontier analysis method. The former mainly uses the Malmquist index to measure the change of efficiency and reflects the quality level of economic growth through the change difference. As for the horizontal method of comprehensive indicators of economic growth quality, since the indicator system covers a large number of indicators and a large amount of information, industrial agglomeration mainly achieves a positive effect on the convergence of economic growth quality by

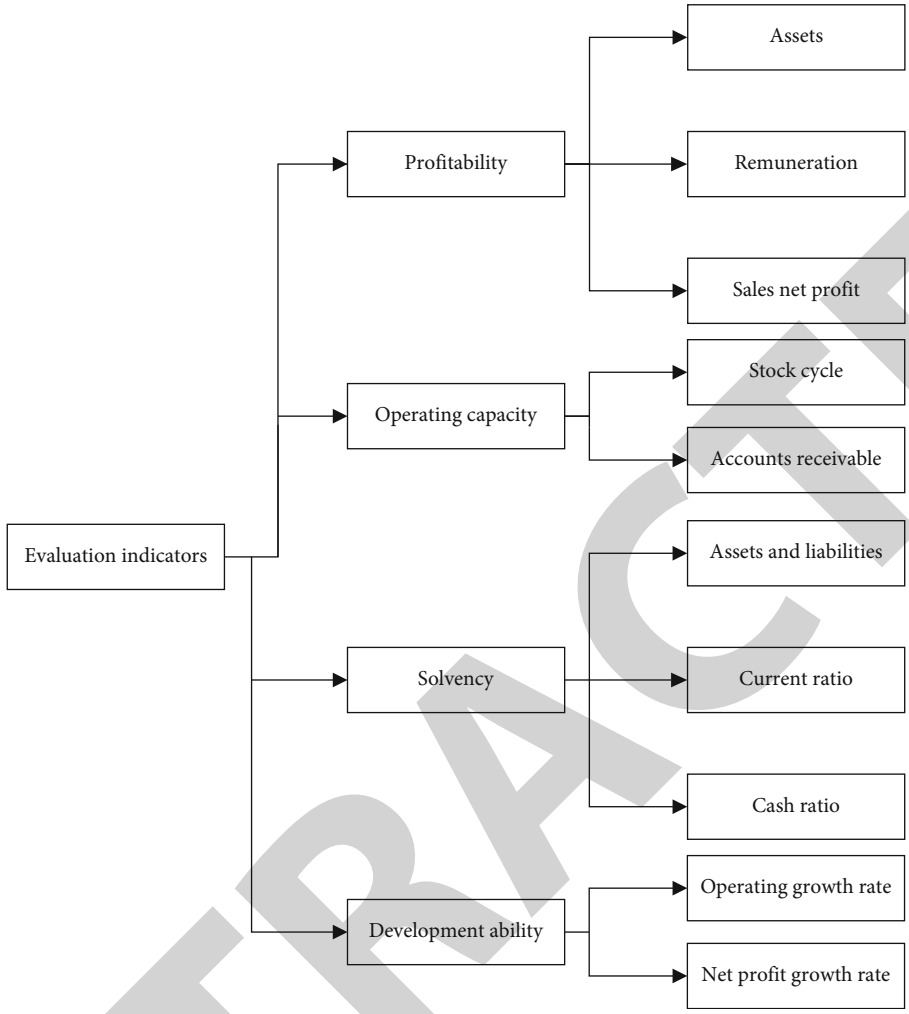

Figure 1: Economic evaluation index.

promoting the convergence of economic growth modes and structures. Therefore, comprehensive indicators are used for measuring. The key lies in the extraction of each indicator information.

2. Factor Analysis

2.1. Implementation Ideas of Factor Analysis. In general, there are multiple indicators in the comprehensive analysis method in the analysis of variables, including profitability, operating ability, solvency, solvency, and development ability. Different indicators have different degrees of correlation, so there is repetitive information, and there are obvious differences in the process of analysis. In order to effectively overcome these obvious differences, factor analysis can effectively solve this problem. The analysis method divides the whole group of indicators into different individual groups according to the matrix, which is based on the principle of principal component analysis theory, and effectively reduces the repetition of information. Common factors exist in different groups, and the original indicators have different characteristics after being rotated by the factors. Different factor loading information can be obtained separately from different original indicators. The extraction of the weight coefficient of each different common factor is obtained by the variance contribution rate. Composite scores and one-way factor scores were obtained by a weighted average method. The economic evaluation index is shown in Figure 1.

2.2. The Connotation and Influencing Factors of the Quality of Economic Growth. For the definition of the connotation of the quality of economic growth, the improvement and optimization of the economic structure belong to the concept of structure. The modern economic growth system is endowed with a broader connotation, such as economic benefits and economic stability and natural and ecological balance, which reflect the meaning of the concept of quality. The connotation of the quality of economic growth can be said that the focus of the connotation is different depending on the research angle. In the past, scholars proposed based on the internal and external perspectives, the perspective of efficiency, and the characteristics of high-quality economic growth, etc., more based on a single perspective. The quality of economic growth should be a comprehensive index with rich connotations, and in recent years, it has a lot to do with the nature and characteristics of the quality of economic

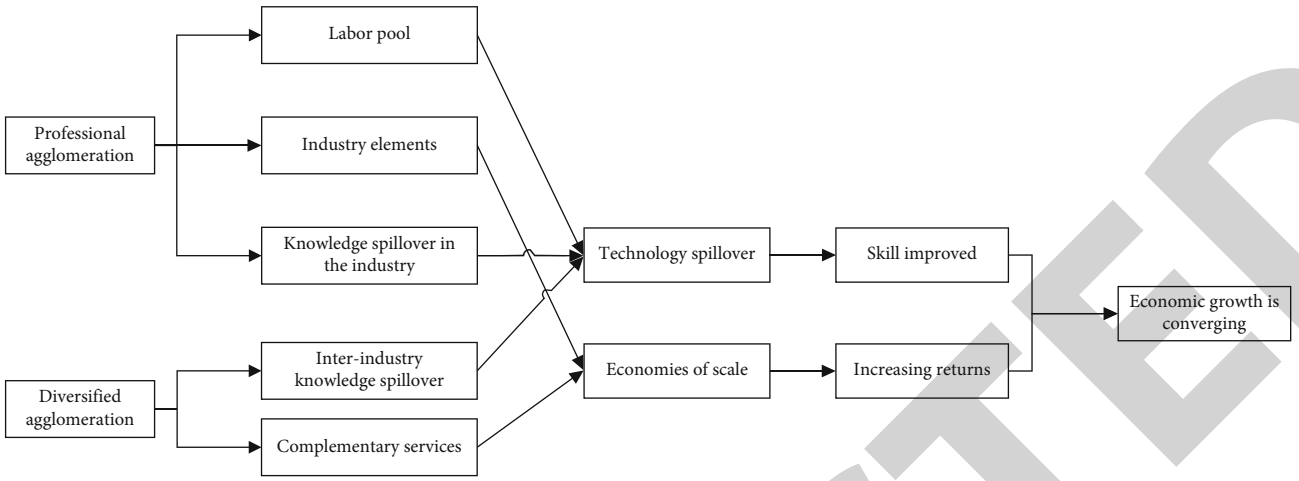

Figure 2: Diagram of the convergence mechanism of economic growth.

growth in the context of high quality. A more comprehensive, systematic, and staged explanation is presented. Comparing the quality and quantity of economic growth, what is the core of the quality of economic growth. The improvement of the quality of growth is due to the improvement of efficiency, the optimization of structure, the improvement of stability, the low cost of ecological environment, the better distribution of welfare, the improvement of innovation level, and some other factors in maintaining the sustainability of economic growth. The evaluation of social and environmental benefits brought about by growth is also one of the goals of the quality of economic growth. It is shown in Figure 2.

3. Algorithm Model

(A) PRINIT [16–20]

Select indicator

$$Ay_t = B_1 y_{t-1} + B_2 y_{t-2} + \cdots + B_s y_{t-s} + \mu_t. \tag{1}$$

Factor analysis method

$$\sum \sigma = \begin{pmatrix} \sigma_1^2 & 0 & \cdots & 0 \\ 0 & \sigma_2^2 & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots \\ 0 & 0 & \cdots & \sigma_k^2 \end{pmatrix}. \tag{2}$$

Dimensionality reduction

$$A = \begin{pmatrix} 1 & 0 & \cdots & 0 \\ a_{21} & 1 & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots \\ a_{k1} & a_{k2} & \cdots & 1 \end{pmatrix}. \tag{3}$$

Quality of economic growth

$$\begin{gathered} y_t = \Phi_1 y_{t-1} + \Phi_2 y_{t-2} + \cdots + \Phi_s y_{t-s} + A^{-1} \sum \varepsilon_t, \\ a_{t+1} = a_t + \mu_{a_t}. \end{gathered} \tag{4}$$

Factor information overlap

$$\begin{gathered} y_t = X_t \beta + A^{-1} \sum \varepsilon_t, \\ \beta_{t+1} = \beta_t + \mu_{\beta t}. \end{gathered} \tag{5}$$

Sample integrity

$$\begin{gathered} h_{t+1} = h_t + \mu_{h_t}, \\ A \begin{pmatrix} \varepsilon \\ \mu_{\beta_t} \\ \mu_{\alpha_t} \\ \mu_{h_t} \end{pmatrix} \sim N \begin{pmatrix} I & 0 & 0 & 0 \\ 0 & \sum \beta & 0 & 0 \\ 0 & 0 & \sum \alpha & 0 \\ 0 & 0 & 0 & \sum h \end{pmatrix}. \end{gathered} \tag{6}$$

Principal [21–23]

$$R_t = 100 \times \mathrm{In}\left(\frac{Y_t}{Y_{t-1}}\right). \tag{7}$$

Information integrity

$$Y_1 = A_1 \times L_1^{1-\alpha} \times \sum_{j=1}^{N_1} \left(X_{1j}\right)^{\alpha}. \tag{8}$$

Common factor

$$\frac{\partial Y_1}{\partial X_{1j}} = \alpha \times A_1 \times L_1^{1-\alpha} \times X_{1j}^{1-\alpha}. \tag{9}$$

Table 1: Assets of Japanese residents in 2015-2019.

Project	2015	2016	2017	2018	2019
Money funds	19459.55	24764.71	27713.31	65229.87	40074.44
Accounts receivable	11066.07	12690.31	15232.42	16498.84	23299.92
Prepayments	131.31	274.73	970.29	3163.23	1066.79
Stock	10161.31	9167	7759.61	23838.99	31568.25
Current assets	59595.99	61087.24	67905.37	117715.61	106753.22
Fixed assets	4793.66	17821.31	15713.69	14382.47	67216.93
Construction in progress	8751.71	278.02	9883.26	38036.33	5508.01
Intangible assets	3418.56	4137.19	3804.44	9097.72	17160.55
Noncurrent assets	21289.07	28157.3	38080.16	68038.81	118595.65
Short-term loan	—	—	—	34200	—
Bills payable	—	1366	2292.21	1890	756.39
Accounts payable	6112.63	6588.1	9735.7	22081.19	30221.22
Advance payment	4039.04	4021.6	5664.64	22533.93	10669.06
Current liabilities	12741.61	16854.48	22875.08	87601.59	59003.97
Noncurrent liabilities	150	185	1357.67	1306.26	38314.54
Debt	12891.61	17039.48	24232.76	88907.85	97318.51
Owners' equity	67993.45	72205.05	81752.77	96846.57	128030.36
Assets	80885.05	89244.54	105985.53	185754.42	225348.8

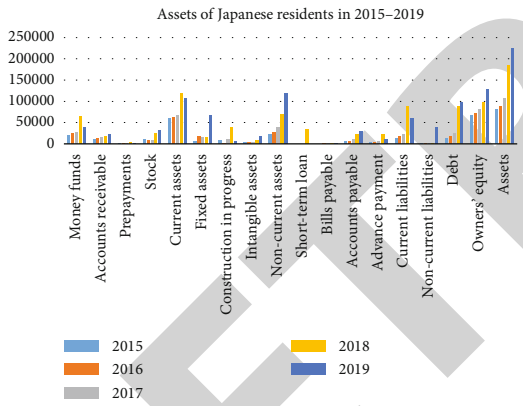

Figure 3: Assets of Japanese residents in 2015-2019.

Convergence

$$X_{1j} = A_1^{1/(1-\alpha)} \times \alpha^{2/(1-\alpha)} \times L_1. \tag{10}$$

Tree structure

$$Y_1 = A_1^{1/(1-\alpha)} \times \alpha^{2/(1-\alpha)} \times N_1 \times L_1. \tag{11}$$

Similar structural features

$$\pi_{1j} = \frac{1-\alpha}{\alpha} \times A_1^{1-\alpha} \times \alpha^{2/(1-\alpha)} \times L_1. \tag{12}$$

Gradient divergence stable scheme

$$\begin{aligned} \gamma_1 &= \frac{1}{\theta} \times \left[\frac{L_1}{\eta} \times \frac{1-\alpha}{\alpha} \times A_1^{1-\alpha} \times \alpha^{2/(1-\alpha)} - \rho\right], \\ Y_2 &= A_2 \times L_2^{1-\alpha} \times \sum_{j=2}^{N_1} \left(X_{2j}\right)^{\alpha}. \end{aligned} \tag{13}$$

Node features

$$x'_{ij} = \frac{x_{ij} - \min\left(x_{ij}\right)}{\max\left(x_{ij}\right) - \min\left(x_{ij}\right)}. \tag{14}$$

System split

$$\begin{aligned} S_{ij} &= \frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}}, \\ e_j &= -k \sum_{i=1}^{n} S_{ij} \mathrm{In}\left(S_{ij}\right). \end{aligned} \tag{15}$$

AHP [24–27]

$$k = \frac{1}{\mathrm{In}(n)}, \quad k \geq 0. \tag{16}$$

Nonphysical boundaries

$$w_j = \frac{d_j}{\sum_{j=1}^{m} d_j}. \tag{17}$$

Table 2: Composition matrix.

	1	2	3	4	5	6
Return on total assets	0.85	0.046	0.012	-0.176	-0.323	0.189
Eps	0.768	-0.086	0.44	-0.051	-0.254	-0.03
Sales cash ratio	0.726	0.083	-0.164	0.377	0.337	0.229
Cash flow ratio	0.705	0.275	-0.542	0.013	0.134	-0.12
Gross profit margin	0.691	-0.473	-0.157	-0.006	-0.169	0.163
Undistributed earnings per share	0.614	-0.093	0.589	-0.014	0.057	-0.322
Operating cash flow per share	0.547	0.2	0.342	0.33	0.508	0.103
Accounts receivable turnover	-0.069	0.783	0.237	0.205	-0.037	-0.29
Total asset turnover	0.009	0.738	0.271	-0.429	0.08	0.137
Roa	0.132	0.711	-0.068	0.436	-0.398	0.009
Inventory turnover	-0.092	0.697	0.147	-0.455	0.088	0.017
Net assets per share	0.4	-0.225	0.633	0.11	0.24	-0.297
Current ratio	0.526	0.072	-0.609	-0.228	-0.021	-0.255
Cash ratio	0.494	0.208	-0.608	-0.128	0.047	-0.285
Total asset growth rate	-0.014	0.173	0.039	0.616	-0.591	0.124
Cash-to-income ratio	-0.098	0.2	-0.211	0.29	0.539	0.397
Net profit growth rate	0.409	0.087	0.239	-0.407	-0.176	0.545

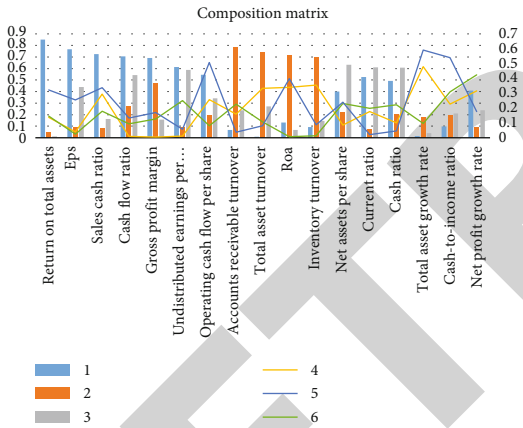

Figure 4: Composition matrix.

Efficiency dimension

$$QEG_i = \sum_{j=1}^{m} w_j \times s_{ij}. \tag{18}$$

Bimodal evolution

$$d(\ln QEG_{it}) = \ln QEG_{it} - \ln QEG_{it-1} = \alpha + \beta \ln QEG_{it-1} + \varepsilon_{it}. \tag{19}$$

Productivity and composite indicators

$$W'_{ij}n = \frac{W^n_{ij}}{\sum_j W^n_{ij}}, \quad i \neq j. \tag{20}$$

Economic structure

$$W^e_{ij} = W^d_{ij}\ \mathrm{diag}\left(\frac{\bar{Y}_1}{\bar{Y}}, \frac{\bar{Y}_2}{\bar{Y}}, \cdots, \frac{\bar{Y}_n}{\bar{Y}}\right). \tag{21}$$

4. Simulation Experiment

4.1. Factor Loading Matrix. In the covariance vector matrix, the current assets, fixed assets, construction in progress, intangible assets, and noncurrent assets in a sample correlation vector are average values. The random sample vector of the random sample correlation vector assumes that the functions of monetary funds, accounts receivable, and prepayments are the main contents of the assets, and the covariance matrix of all sample variables is obtained by standardizing and normalizing all the data. The variance matrix is consistent with the same sample matrix. Then, the common load factors of different indicators (short-term loans, bills payable, accounts payable, advance receipts, and current liabilities) are rotated, and the way of rotation is to rotate 90 degrees. As shown in Table 1 and Figure 3, the common load factors show different quantification and different degrees of clarity in different indicators and can also effectively determine the number of load factors and load information of the common load factors in different indicators, so that the public index factors can be accurately and quickly determined. Integrity principal residents' financial risk is composed of many factors, not only unilateral factors but also the following factors: determining influencing factors, selecting indicators, and discovering risks and potential dangers. Financial risk itself is comprehensive, and the assessment of risk arising from a single factor is less important.

4.2. Indicator Selection. The most important thing in the accurate and comprehensive evaluation of financial performance is to establish an evaluation index system suitable

Table 3: Comprehensive score.

	F1	F2	F3	F4	F5
2000	0.41648	0.55995	1.49627	0.26501	0.34
2001	0.41606	0.65002	1.50912	0.65535	0.43
2002	0.52557	1.49627	1.00702	0.43894	0.36
2003	0.05688	0.77781	1.09591	0.16	0.44
2004	0.00568	0.93516	0.85469	0.48423	0.39
2005	0.20467	1.06447	0.49352	0.14716	0.35
2006	0.07067	1.04538	0.37502	0.01034	0.32
2007	0.17083	1.00702	1.70869	0.04021	0.1
2008	0.53396	0.81243	1.77782	0.91184	0.29
2009	0.66739	0.7232	0.95664	1.1617	0.49
2010	0.52557	0.78161	1.31122	2.60109	0.53
2011	3.64246	0.76692	0.53378	0.25094	1.55
2012	0.03782	1.28212	0.37827	0.83716	0.36
2013	0.44595	0.61294	0.7972	0.46002	0.12
2014	0.90593	0.44733	0.04924	0.43268	0.21
2015	0.90204	0.30946	0.40893	0.31798	0.32
2016	0.69659	1.7071	0.42569	0.25094	0.2
2017	1.06	1.42669	0.25746	2.71944	0.49
2018	0.85075	1.27471	0.19437	0.15926	0.71
2019	0.3077	1.29736	0.22135	0.6245	0.28

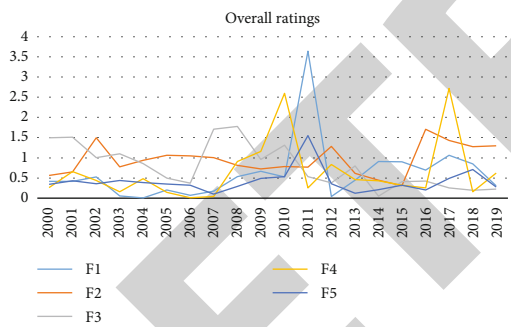

Figure 5: Comprehensive score.

for development. As shown in Table 2 and Figure 4, feasibility is the basis for data selection and data analysis. The requirements for the selected financial indicators are that the unit and order of magnitude should not only be accurate but also consistent, the financial information reflected by the selected financial indicators should be direct and clear, and financial data should be obtained in multiple ways, through annual reports and the Internet; the financial data is collected. The analysis of financial performance based on scientific principles can show the current operating conditions, so the selection of financial indicators must be true, effective, and objective, so as to correctly reflect the real situation, and it is beneficial to combine the analysis results and carry out the following steps. One-step planning layout. Systematic principle financial indicators are both independent and closely related to each other and affect each other, which is an organic whole with complex logical relationship. Therefore, the selection of financial indicators should be systematic and complete, not only to explain the financial situation individually but also to analyze the financial situation from a global perspective as a whole. The principle of comparability needs to carry out horizontal and vertical analysis and will compare and analyze the financial data of different years in the chemical industry, so the selected financial indicators should be comparable, which is conducive to financial performance.

4.3. Economic Quality Analysis. The way of debt-based operation has uncertain risks to the financial rights and interests of stakeholders. If there are too many debts, the operation situation has not been well improved, and the debt cannot be repaid within the specified time limit, which will lead to financial difficulties. If there is no improvement, there will be the risk of bankruptcy. Being affected by the internal environment and improper management methods will also generate risks, including external factors such as macroeconomic policies and changes in the market environment. Due to these influencing factors, the risk of loss and income is uncertain, which has brought an adverse impact on the financial situation and led to the generation of financial risk. In 2017, the score was higher: 0.25746,F4 = 2.71944,F5 = 0.49. In general, the concept of financial risk is still very holistic. The various business links that it produces may occur in the process of financing or in the process of investment. Compared with the narrow concept, the financial risk in the broad sense is more in line with the characteristics of risk, and it arises from each link related to financial activities. It is based on the analysis of financial risk in a broad sense. As shown in Table 3 and Figure 5, it can be seen that the economic quality scores were higher in 2011 and 2017.

Table 4: Key factors of economic growth.

Year	HHI	Gini	THEIL	CV
2005	0.0038	0.156	0.0378	0.2798
2006	0.0037	0.127	0.0253	0.2293
2007	0.0037	0.1209	0.023	0.2176
2008	0.0036	0.1051	0.0187	0.2005
2009	0.0036	0.1131	0.0207	0.2072
2010	0.0036	0.0955	0.0154	0.1804
2011	0.0036	0.0926	0.0152	0.1816
2012	0.0036	0.0874	0.0131	0.1665
2013	0.0036	0.0894	0.0136	0.1698
2014	0.0035	0.089	0.0138	0.1724
2015	0.0035	0.083	0.0121	0.1583
2016	0.0035	0.0791	0.0111	0.1505
2017	0.0035	0.0612	0.0069	0.1183
2018	0.0035	0.0729	0.0097	0.1425

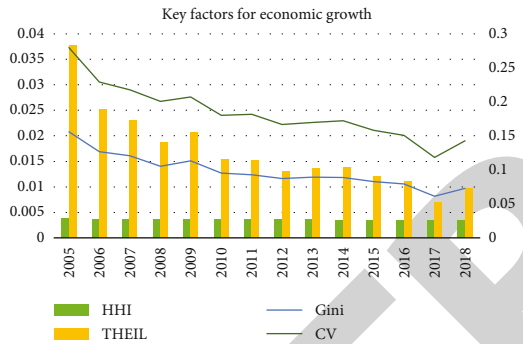

Figure 6: Key factors of economic growth.

4.4. Key Factors of Economic Growth. The key factors for economic growth include gross national product, inflation, employment rate, and the balance of payments. These factors were analyzed and compared using factor analysis. In the univariate evaluation, the evaluation process lacks comprehensiveness and integrity, so the use of this model is limited. Use multivariate statistical methods to construct linear functions of several variables. Assess financial risk based on the results. It makes up for the shortcomings of using only one variable in the univariate model method and makes the evaluation results more comprehensive. However, this method has higher requirements on data, and the data should be normally distributed, but this condition cannot be satisfied in all cases, and the model is complex. Refer to expert opinion and qualitative and quantitative analysis of the actual situation. The principle is simple and easy to practice. However, the expert judgment is used in the analysis process, which is easily affected by human subjectivity, which may make the analysis results lack certain objectivity and scientific. Factor analysis uses a small number of factors to represent complex variable relationships. According to the matrix formed by the selected variables and the internal relationship between them, HHI = 0.0038 , Gini = 0.156, THEIL = 0.0378, and CV = 0.2798 were used to replace the original variables for analysis and used to explain the problems of the Japanese economy. The selected data are objective, and the meaning of the factors extracted from the original data cannot be accurately determined. The factor analysis method can solve such problems to a large extent because of its advantages of simplifying analysis indicators and simple operation and can quickly obtain financial risk evaluation results while ensuring a high accuracy rate. It is shown in Table 4 and Figure 6.

5. Conclusion

Factor analysis is suitable for the conditions of complex correlation, large sample size, many influencing factors, and many selected indicators; able to conduct research on a variety of subjects; and can better apply multivariate statistical methods to the evaluation of financial performance. Among other common methods of evaluating financial performance, factor analysis methods can reduce dimensionality and simplify data basically design weights. Factor analysis can reduce the dimensionality of data even with large sample sizes. It avoids a lot of complicated calculations, reduces the difficulty of calculation, and solves the problem of overlapping factor information, reflecting the advantages of multivariate statistics. Based on the factor analysis method, this study analyzes the quality analysis and key factors in Japan's economic growth: (1) integrity principle residents' financial risk is composed of multiple factors, not only unilateral factors but also the following factors: determine the influencing factors, select indicators, and identify risks and potential hazards. Financial risk itself is comprehensive, and the assessment of risk arising from a single factor is less important. (2) The requirements for the selected financial indicators are that the unit and order of magnitude should not only be accurate but also consistent, the financial information reflected by the selected financial indicators should be direct and clear, and financial data should be obtained in multiple ways, through annual reports and the Internet, to collect financial data. The analysis of financial performance

based on scientific principles can show the current operating conditions, so the selection of financial indicators must be true, effective, and objective, so as to correctly reflect the real situation, and it is beneficial to combine the analysis results and carry out the following steps. One-step planning layout. (3) Financial risks may arise in the process of financing or in the process of investment. Financial risk in a broad sense is more in line with the characteristics of risk, and it arises in every link related to financial activities. The analysis is carried out in terms of financial risk in a broad sense. It can be seen that the economic quality scores were higher in 2011 and 2017. (4) Use several representative factors to replace the original variables for analysis, and explain the problems existing in the Japanese economy according to the results. The key factors for economic growth include gross national product, inflation, employment rate, and the balance of payments.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declared that there are no conflicts of interest regarding this work.

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Retraction

Retracted: Corporate Financing Constraints and Information Disclosure: An Analysis of Corporate Investment Dilemmas under the Wave of Counter-Globalization

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] L. Xu, Q. Duan, and X. Cao, "Corporate Financing Constraints and Information Disclosure: An Analysis of Corporate Investment Dilemmas under the Wave of Counter-Globalization," *Journal of Sensors*, vol. 2022, Article ID 7957187, 11 pages, 2022.

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Research Article

Corporate Financing Constraints and Information Disclosure: An Analysis of Corporate Investment Dilemmas under the Wave of Counter-Globalization

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Open and transparent market information is a prerequisite to maintain the order of financial market and guarantee the normal financing of enterprises. In the real financial market, there is inevitably market information asymmetry. Information asymmetry has become a key factor in corporate financing constraints, and capital market information disclosure is conducive to solve problems such as information asymmetry in the capital market and smooth the financing channels of companies. In the process of economic globalization, some developed countries and industrial classes with damaged interests have set off a wave of counter-globalization, under which export-oriented enterprises in various countries are facing a series of investment dilemmas, which affect their choice of investment direction. In this paper, we study the relationship between corporate financing constraints and information disclosure, introduce information disclosure quality indicators and financing constraint measurement models, and analyze corporate investment dilemmas based on international disputes under the wave of counter-globalization.

1. Introduction

Adequate capital is the source and guarantee for the normal operation of enterprises, and financing activities play an important role in raising capital for enterprises and play an irreplaceable role in securing the source of capital for enterprises. Financing constraints are a series of dilemmas faced by enterprises in financing. As a major problem for enterprises, the financing constraint is mainly reflected in two aspects: firstly, in the quantity of financing, due to the influence of inflation, the CPI (Consumer Price Index) is rising, and the government implements a tight monetary policy, and then, those enterprises that originally have financial difficulties will declare bankruptcy due to the shortage of funds. The second point is the access to financing: in the Chinese capital market, for example, commercial banks in the context of the debt financing market "discriminate" in providing loans to different enterprises [1]. The reasons for this "discrimination" are, on the one hand, institutional factors, i.e., most Chinese commercial banks are state-owned, and when granting credit, banks prefer state-owned enterprises or state-controlled enterprises with which they have a closer relationship, while private enterprises are often not favored by commercial banks; on the other hand, market selection is to prevent and resolve. On the other hand, in order to prevent and solve financial risks, commercial banks that provide loans to enterprises prefer to lend to those enterprises with balanced financial balances and reasonable corporate management structures.

In the capital market, the degree of information symmetry is a factor that cannot be ignored by investors. The degree of accuracy of information, the speed and fluency of the information transmission process, and the ability to use information directly determine the success or failure of investors. In reality, there is a serious information asymmetry in the capital market. The capital market information disclosure has an irreplaceable role in promoting the openness and transparency of market information by publicly disclosing the company and company-related information to the public and investors [2]. Information disclosure has

gradually become a strong driving force for the development of the capital market and an effective guideline for resolving market information asymmetry, and it is a hot issue in modern finance research that keeps appearing in people's eyes.

Counter-globalization is the inevitable product of economic globalization after its inherent shortcomings are exposed at a certain stage of development. The original purpose of economic globalization is to promote the economic development and prosperity of all countries in the world, but when the superiority brought by this phenomenon cannot compensate for the disadvantages it causes, it will make part of the masses lose their confidence in economic globalization and thus oppose the development of economic globalization. The most affected enterprises under counter-globalization are the outward-oriented enterprises targeting overseas markets. Under this wave, export-oriented enterprises face various investment dilemmas.

2. Research Background

In the 1980s and 1990s, the General Agreement on Tariffs and Trade (GATT) was replaced by the World Trade Organization (WTO), which opposes tariff barriers and advocates and pursues free trade, as the world landscape evolved [3]. At the same time, the rapid development of aviation and shipping, computers, Internet, precision instrument manufacturing, and mobile communication technologies created favorable conditions for the optimal allocation of global production factors, promoted the improvement of the global production value chain, and facilitated the smooth development of international division of labor cooperation. Based on the new form of international division of labor, multinational companies of developed countries allocate the production of products in different production cycles to countries and regions with higher abundance of production factors (the state of resources owned by a country) in order to facilitate the pursuit of the highest profits [4]. However, placing production factors into international production, multinational companies always monopolize the most valuable stages of the production value chain, i.e., research and development, design, marketing links, etc., while transferring low-profit, low-technology stages such as assembly, manufacturing, and processing to developing countries and regions, breaking the inherent pattern of product value chain distribution within global trade and determining the final pattern of international division of labor. The division of labor in the production value chain of products is shown in Figure 1.

In 2008, the financial crisis broke out in the United States and spread to the world financial and economic markets. The total demand of the global economy fell off a cliff and the growth rate of international trade dropped by about 50%. At the same time, the foreign investment of overseas enterprises and multinational corporations worldwide shrank significantly [5] and has been in the doldrums for several years since then, with no sign of recovery so far and a large difference from the level before the outbreak of the crisis. The economic development of the world's major economies, represented by the United States and Japan, is far from what it used to be, and the gap between the rich and the poor has widened. The worldwide wave of antiglobalization was triggered by the "Occupy Wall Street" movement in the US in 2011, after which the wave of antiglobalization began to spread around the world with the US as the center. However, the wave of counter-globalization at this stage was only in the private sector, and the main promoters were the private sector. A series of international political events, such as the trade frictions between the United States and China, the announcement of the United Kingdom's withdrawal from the European Union, and the growing popularity of populist parties in France, Germany, and Italy, all signaled a new wave of reverse globalization [6]. Enterprises in various countries can no longer ignore the impact of the wave of counter-globalization on their own development, and then, they have to seek a benign development path to help them transform and upgrade to help themselves out of their investment difficulties.

Unilateralism, protectionism, and feudal secularism are on the rise. The current wave of counter-globalization is driven by governments and has a new political character. In international trade and investment, the main features of reverse economic globalization are reflected in the gradual marginalization of multilateral trade and bilateral trade advocated by the WTO and the collapse of global multilateral trade and investment rules and governance mechanisms in the General Free Trade Agreement and the opening of a reconstructed pattern of the original global industrial chain of multinational corporations in specific countries and regions [7]. For example, in recent years, many MNCs from the US, UK, Korea, and Japan have started to leave China and move to other emerging economies or to other developing countries. In addition, in order to hinder the realization of the "Made in China 2025" goal, the United States, under the guise of balancing the trade deficit with China, announced in 2018 a significant increase in tariffs on more than 500 billion dollars worth of goods exported from China to the country, despite twelve rounds of negotiations between China and the United States in September 2019. The US side still decided to impose an additional 5% tariff on more than 500 billion worth of goods imported from China. Not only that, Trump also called on domestic multinational companies to transfer overseas manufacturing orders from China to their home countries as soon as possible after taking office and introduced a series of policies to attract foreign investment in a bid to revitalize domestic manufacturing and improve domestic employment. The US tariff rates on products imported from China from 2017 to 2019 are shown in Figure 2.

As can be seen from the data in Figure 2, in just two years, the average US tariff on China has risen from less than 4% to 24.3%, an increase of about 21%. The average tariff in 2018 was about 12.5%, up about 9.4% compared to 2017, and the average tariff in May 2019 was about 18.5%, up about 6% compared to 2018, showing a rapid rise in the overall tariff level. The monthly amounts of US imports from China in September and December are shown in Figure 3.

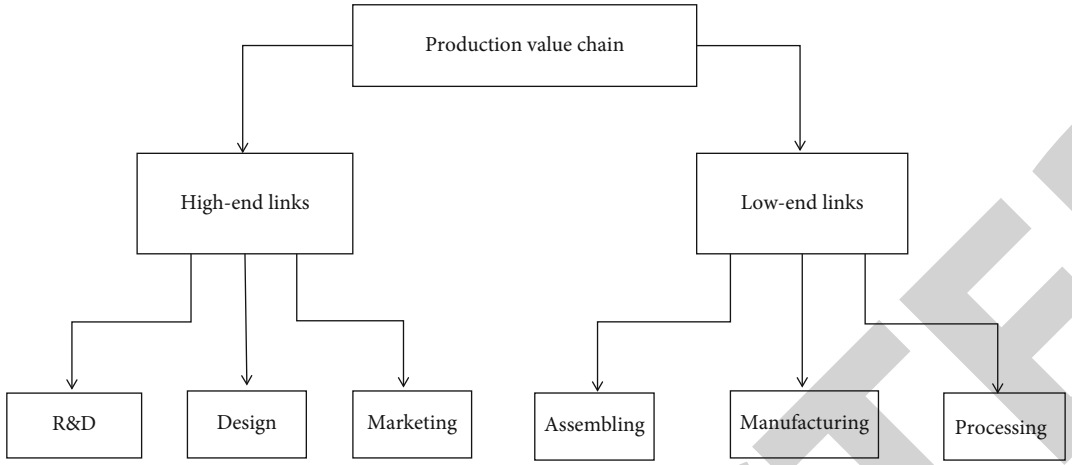

Figure 1: Production value chain division of labor links.

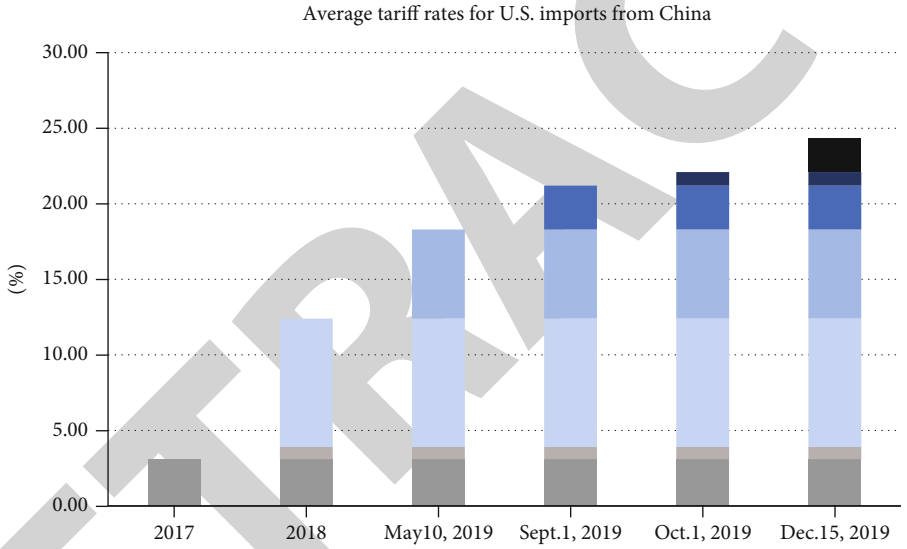

Figure 2: Historical trend of the average US tariffs on China, rising from 3.1% to 24.3% in a two-year period.

The blue curve from Figure 3 represents the September 1 list (including only textiles, footwear, and apparel), and the orange curve represents the December 15 list. The total title of the tax increase list in September shows a stable state, hovering around $300 million, with the highest not exceeding $400 million and the lowest not less than $200 million. The tax increase list changes more significantly in December and shows a clear peak state with a cyclical character [8]. The lowest monthly amount of each year usually occurs from March to May, and the highest monthly amount usually occurs from November to December. And the minimum monthly amount is not less than 800 million USD, and the maximum monthly amount is not higher than 2 billion USD.

In the new context of reverse economic globalization, multinational companies have started to reorganize their internal industrial chain and reshape the global value chain through a series of measures. What are the challenges that contemporary export-oriented enterprises will face in the process of integrating with global value chains? Are there any measures and methods to solve these difficulties? Therefore, a reasonable analysis and prediction of the risks and challenges that the current external environment of counter-globalization will bring to outward-oriented enterprises' foreign investment is a practical way for these enterprises to mitigate the adverse effects of counter-globalization on their own investment activities, as well as to facilitate the innovative development of outward-oriented enterprises, optimize their industrial structure, and improve their trade level.

3. Materials and Methods

3.1. Information Disclosure and Financing Constraints

3.1.1. The Effect of Information Disclosure on Financing Constraints. In the 1970s, Akerlof proposed the principle of "lemon market" for market information asymmetry,

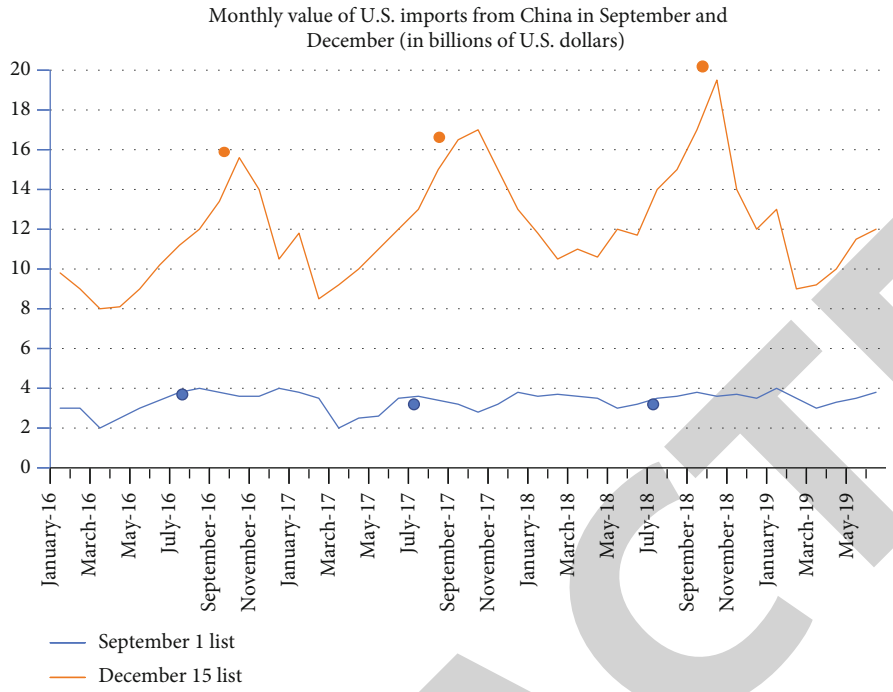

Figure 3: Changes in monthly import amounts of goods in the September tariff increase list (blue line) and December tariff increase list (orange line).

explaining in detail how buyers and sellers in a market can cause market failure due to information asymmetry. Jensen and McLean (1976) expressed the view that whether equity or debt financing is undertaken, the insider structure cannot avoid the imbalance of power and responsibility due to distorted incentives. In the case of debt financing, low financial leverage creates concerns for insiders and makes them conservative in their investment behavior when the cost of bankruptcy is not accounted for. High financial leverage, on the other hand, can have an aggressive effect on insiders' investment behavior. Although insiders' investment behavior is risky at this point, it is often accompanied by high returns if successful. If the investment is unsuccessful, most of the resulting losses are borne by the creditors [9]. Based on the above logic, Jensen and McLean (1976) published the concept of cost replacement of financial market contracts, i.e., in principle, the existence of a specific capital structure that can dissolve the replacement cost of financial contracts. The existence of replacement costs leads to the fact that the cost of internal financing is less than that of external financing that the two cannot produce a substitution elimination relationship, and that as long as the size relationship between the two does not change, the phenomenon of corporate underinvestment will occur because the total amount of funds necessary for investment spending cannot be met. Green-Wald combines the above theories to propose the idea that risk premiums accompany information asymmetry, showing that investors' expected returns increase due to the increase in the level of risk premiums, while other investment projects lose market competitiveness due to the level of risk premiums that do not meet investors' expectations, and firms that focus on such projects will face the pressure of greater financing constraints.

Information asymmetry can undermine the rules of market transactions, interfere with market order, and hinder the role of market mechanisms. An effective way to eliminate market information asymmetry is based on studying the behavior of vendors in economic statistics. Generally speaking, manufacturers are motivated by the purpose of profit maximization, and their decisions can reflect to some extent the heart expectations and actual situation of manufacturers. On this basis, the signaling theory was developed. According to the signaling theory, the investment and financing decisions of investors send signals to the outside world about the financial information and development status of the manufacturer [10]. Usually companies whose financing structure is chosen with signaling effect are high-quality companies. Based on the increase in the proportion of debt financing, the capital market sends the message that having quality investment projects does not mean that the company's management will favor equity financing when the share price is higher than the market value, because the choice of equity financing will send the wrong message to the market and bring negative effects, which will eventually bring about a fall in the share price. In addition, excessive administrative intervention will further exacerbate the degree of information differentiation in market behavior. As the pace of socialist market economy with Chinese characteristics accelerates and market allocation occupies a dominant position in resource allocation, the transparency and openness of the market environment becomes a necessary condition to adapt to market allocation of resources. This

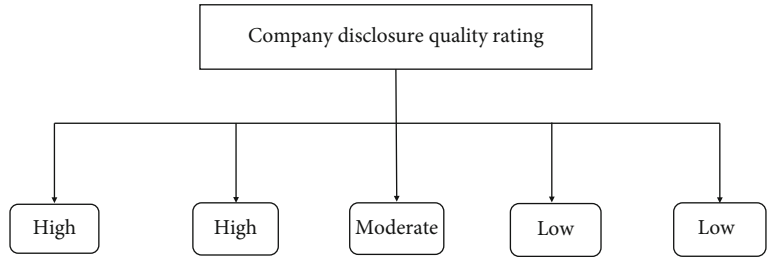

Figure 4: Company information disclosure quality rating.

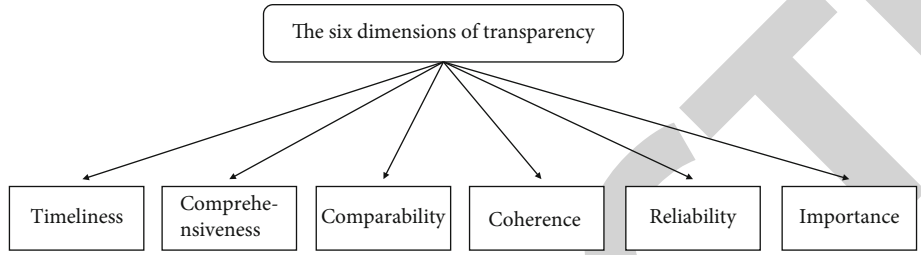

Figure 5: The six aspects of transparency.

requires an information disclosure system to be implemented for listed companies in order to promote openness and transparency of the market and improve market efficiency.

The Shanghai Stock Exchange and Shenzhen Stock Exchange jointly issued the Information Disclosure Work Assessment Program for Listed Companies (hereinafter referred to as "the Program") in June 2001 [11]. The Program stipulates that the exchange mainly evaluates the rewards and punishments of listed companies and provides a certain degree of public disclosure of accurate, complete, and legal information to meet the principle of transparency and openness of market transactions. Based on the evaluation results, the company's information disclosure is classified into five levels from high to low: high, high, moderate, low, and low. The evaluation results are publicized in the securities trading section of the company for the reference of the public, as shown in Figure 4.

3.1.2. Selection of Information Disclosure Quality Indicators. Although the importance of the information disclosure system has attracted a high degree of attention from all walks of life, it still lacks a clear unified indicator for measuring the quality of information disclosure. Each enterprise should grasp a certain proportion when implementing information disclosure, in order to avoid not only too much information concealment caused by insufficient information disclosure, but also leakage and damage to the company's interests caused by excessive information disclosure. In April 1996, the US Securities and Exchange Commission introduced the concept of transparency as an important indicator of information disclosure. Generally speaking, transparency refers to how easy it is for information users to grasp information on capital flows of listed companies by means of accessing data. With the joint efforts of some experts and scholars, the concept of transparency has been supplemented and refined, based on which the Basel Committee has divided transparency into six aspects, as shown in Figure 5.

According to the above division criteria, scholars at home and abroad mainly obtain information disclosure measurement indexes through three ways.

One is to study the indexes specified by scholars themselves. For example, Botosan (1997) classifies the information voluntarily disclosed in the annual reports of companies and sets various specific items according to the characteristics of each type of information and finally produces 28 indicators to measure the quality of information disclosure according to the principle of transparency and sets the corresponding ratio for these indicators to score, and the final result represents the level of information disclosure quality. The second is the measurement indicators from the side of authoritative institutions. Third is the selection of certain alternative indicators that can reflect the quality of information disclosure of the company, such as the selection of surplus quality and earnings opacity [12].

3.2. Financing Constraint Metric Model

3.2.1. Sample Selection and Data Sources. The sample data chosen by the researchers are selected from the Shenzhen Stock Exchange. In addition, due to the special nature of the financing method of ST companies, there are significant differences between such companies and the traditional disclosure system of listed companies. In order to eliminate the interference and influence of the sample differences on the research process, such companies are not suitable as research subjects and need to be eliminated. And in order not to be affected by the extreme values, the researchers excluded the data samples that exceeded 10% of the mean.

3.2.2. Model Design. The model used in this paper is the financing constraint model proposed by Almeida in 2004. According to the design concept of the model, when a listed

Table 1: Specific definition and description of each variable.

Variable name	Variable definition	Variable description
ΔCH	Cash holdings	Cash holdings = net increase in cash and cash equivalents/total assets at end of period
BJ	Cash flow	Net cash flow from operating activities/total assets at end of period
CL	Information disclosure quality	Excellent, good, pass, and fail are set as 1, 2, 3, and 4 in that order
FM	Financial development level index	FM1, FM2, and FM1 indicate the total loans of financial institutions in each region/GDP in each region; FM2 indicates the total stock market value in each region/GDP in each region
SIZE	Company size	Take the logarithm of average total assets
NMC	Net working capital	Net working capital = (current assets − current liabilities)/total assets at the end of the period
Tobing	Company growth capacity	The ratio between the market value of a company and its replacement value, where market value equals the sum of stock value and bonds, and replacement value refers to the book value of the company. The equity value of a company's market value consists of two components: the value of current shares and the value of nonmarketable shares

company faces the problem of financing constraints, a smart operator will plan well between the internal cash flow of the company now and the future cash flow, and whenever there is a positive NPV item, the company will be able to use the cash flow from inventory as a financing item and other financing needs [13] and take a portion of the current cash flow as a prefunding of future cash flow for occasional needs. Almeida determined the final basic model of corporate financing constraints after a series of mathematical proofs. The researchers used the following extended model based on the basic model, adhering to the extended model can be expressed in the following equation:

$$\text{DependentVariable} = \alpha + \beta_i \text{ExplanatoryVariables} + \gamma_i \text{ControlVariables} + \varepsilon. \quad (1)$$

According to the above model, the explanatory variables are BJ, CL, BJ ∗ CL, FM1, FM1 ∗ BJ, FM2, and FM2 ∗ BJ. BJ denotes net cash flows generated for capital activities/average total assets, CL denotes disclosure quality, and FM denotes the level of financial development. The control variables are SIZE, NMC, and Tobing. SIZE denotes the size of the firm, NMC denotes liquidity/average total assets, and Tobing denotes the firm's ability to grow. ε represents the residuals, and the explanatory variable is CH, which is interpreted as net increase in cash and cash equivalents/average total assets. The specific definitions of the variables are shown in Table 1.

According to Almeida's basic model and the theoretical study made in this paper, it is possible to make the following measurements: if a listed company has a financing constraint dilemma [14], its cash flow from operating income will have a greater impact on the company's cash inventory, which can also be understood that the company will be too dependent on the internal cash flow for the funds needed for future investments.

To ensure the reliability and completeness of the results, this paper uses the improved investment model equations to make a test of the Almeida basic model. The basic equation of the improved investment model equation is shown as follows:

$$\left(\frac{I}{K}\right)_{it} = \beta_0 + \beta_1 \left(\frac{I}{K}\right)_{i,t-1} + \beta_2 \left(\frac{I}{K}\right)^2_{i,t-1} + \beta_3 \left(\frac{Y}{K}\right)_{i,t-1} + \beta_4 \left(\frac{\text{CF}}{K}\right)_{i,t-1} + \varepsilon_{it}. \quad (2)$$

In equation (2), i represents the company, t represents the year, I represents the investment expenditure (cash paid for fixed asset investment), K represents the initial total assets, Y represents the main business income, and CF represents the cash flow (net cash flow generated by the operating activities of the enterprise).

4. Results and Discussion

4.1. Statistical Analysis of Information Disclosure Appraisal Results. By using the financing constraint model, the results of information disclosure appraisal are obtained as shown in Table 2.

The data in the table showed the overall quality preference of information disclosure of listed companies from 2017 to 2021. The number of qualified or above companies accounted for 96.28% of the total number of companies, among which the number of companies with good information disclosure quality accounted for 59.11%, and the number of excellent companies accounted for 10.08%. From the overall change trend of time, the quality of information disclosure of the company shows a trend of improvement year by year. The proportion of unqualified companies in information disclosure is decreasing year by year, from 6.70% in 2017 to 1.93% in 2021. The number of companies with good information disclosure quality is on the rise. The number of companies with excellent information disclosure quality also increased from 56.61% in 2017 to 68.96% in 2021. The number of companies with excellent information disclosure quality also increased from 9.31% in 2017 to 11.59% in 2021.

Table 2: Results of information disclosure assessment.

Year	Excellent		Good		Qualified		Failed		Total
	Number of companies	Proportion	Number of companies	Proportion	Number of companies	Proportion	Number of companies	Proportion	
2017	50	9.31%	304	56.61%	147	27.37%	36	6.70%	537
2018	55	9.30%	316	53.47%	189	31.98%	31	5.25%	591
2019	64	9.03%	375	52.89%	243	34.27%	27	3.81%	709
2020	82	10.57%	468	60.31%	208	26.81%	18	2.32%	776
2021	96	11.59%	571	68.96%	145	17.51%	16	1.93%	828
A combined	347	10.08%	2034	59.11%	932	27.09%	128	3.72%	3441

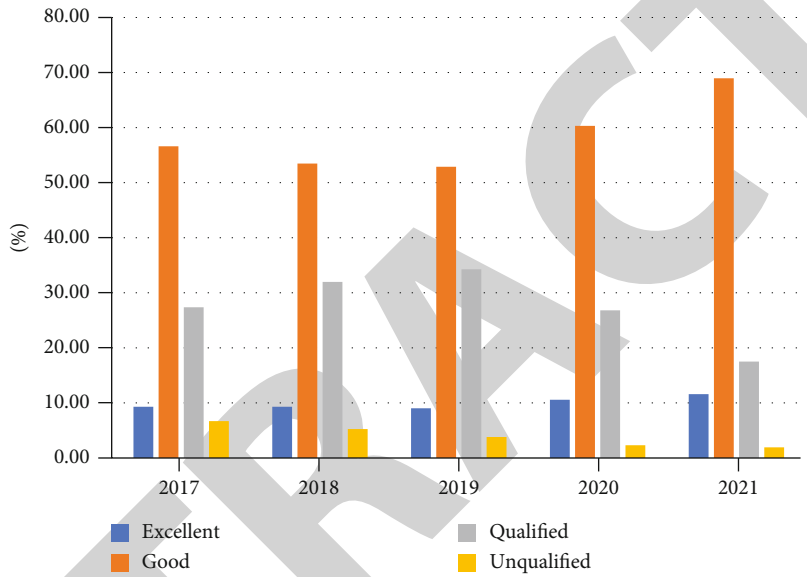

Figure 6: Trend chart of information disclosure evaluation results of listed companies from 2017 to 2021.

The trend chart of information disclosure evaluation results is shown in Figure 6.

4.2. The Dilemma of Enterprise Investment in the Antiglobalization Tide

4.2.1. Enterprise Safety Margin Reduction. In recent years, global trade and investment rules under the WTO have not changed significantly despite the maneuvering of various parties and multiple rounds of negotiations. Therefore, multilateral trade rules in the international economy are impacted by bilateral free trade negotiations in a smaller scope between the two countries, rather than bilateral or multilateral trade rules in a larger scope, which can be regarded as the practical outcome of the antieconomic globalization wave [15]. In 2017, US President Donald Trump called for the reestablishment of multilateral trade agreements. In his view, the US must withdraw from existing multilateral trade agreements and negotiate new ones with UN member states.

Based on the change of the international social environment, economic globalization also presents new characteristics; under these characteristics, free trade, trade protectionism, all sorts of unilateralism, and nationalism raged; the world economic and trade rules and investment philosophy system are impacted by the multilateral trade agreements and strong fund forces under the inverse wave of economic globalization; the developed countries will choose in order to realize the expected benefits and some emerging countries or the developing countries to carry out international trade [16], in the international industrial division of labor cooperation, on the basis of both sides to find a benefit balance, on the premise of not damage the interests of their own respective, through investment optimization effect in promoting the benign development of the enterprise. For example, Argentina from the Americas, Myanmar, and Laos in Asia, Rwanda, Nigeria, and other developing countries in Africa are likely to benefit from the new pattern of international industry created by counter economic globalization. This has forced multinationals to rethink their overseas development strategies and consider locating more of their manufacturing in their home countries. As a major manufacturing country in the world, China has incomparable manufacturing advantages. This is due to

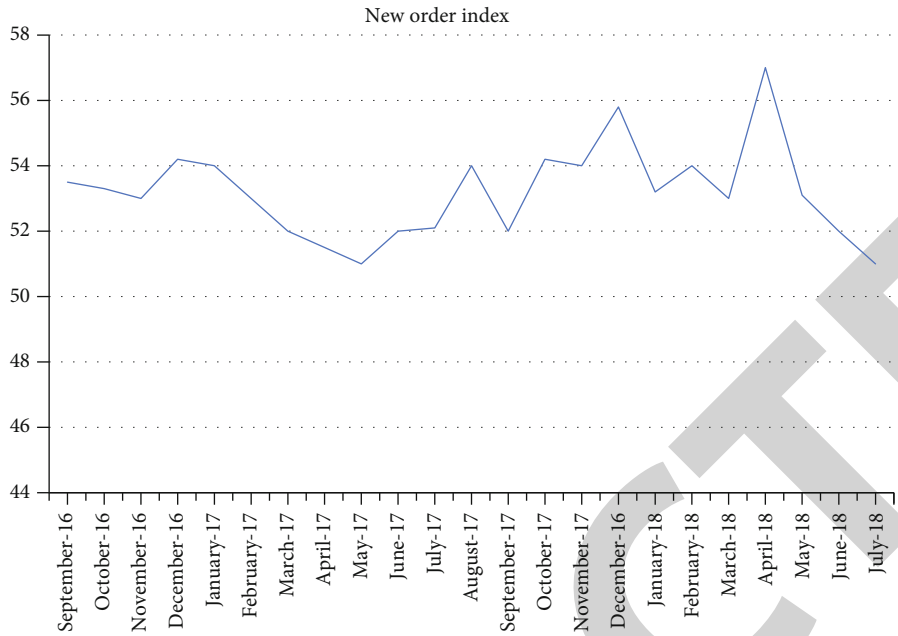

Figure 7: Index of new orders from overseas from 2016 to 2018.

the fact that developed countries have transferred the middle and low-end manufacturing and processing parts of the industrial chain to China. Chinese enterprises engaged in labor-intensive industries are facing severe external environmental impact in their overseas investment.

As can be seen from the data in Figure 7, the index of new orders from overseas showed a trend of fluctuation from 2016 to 2018, with a large variation range. This shows that the overseas investment environment is unstable and influenced by too many restrictive factors, which affect the investment environment of Chinese enterprises.

4.2.2. External Pressure from Developed Countries and the Disappearance of Demographic Dividend Make the Living Environment of Enterprises Deteriorate. Against the backdrop of frequent economic cooperation and exchanges in the world, developing countries with a weak industrial base have optimized and upgraded their industrial structure, raised the overall level of industrialization, and significantly enhanced their economic strength in the process of taking over industries from developed countries. The deviation in the understanding of economic globalization between developed and developing countries makes people doubt to varying degrees the world multilateral trade and investment rules and governance system with WTO as the core, and the inherent international economic pattern appears to be difficult to support in isolation under the impact of antiglobalization and is facing collapse at any time [17]. Against this backdrop, many overseas companies from the US, Germany, Japan, France, and other countries have withdrawn from China in recent years. This reveals a kind of information: developed countries will target the emerging market countries that can undertake the international industrial gradient transfer and begin to reconstruct their global industrial value chain. In addition, some developing countries located in the southern part of South America and Southeast Asia are sending signals to developed country TNCs to seek cooperation, relying on their advantages of lower cost land and labor than developed countries. And these countries have also launched a series of policies and measures to attract outward investments, which are expected to absorb foreign investments brought by the new counter-globalization features, thus integrating them into the global value chains of MNCs. Therefore, Chinese enterprises in the industrial chain are still under the threat of Western MNCs taking advantage of this opportunity to reduce the order offer of OEM (OEM) enterprises in China, which will make Chinese enterprises face a dilemma: either accept the MNCs' price reduction or face the situation that long orders become short orders, empty orders become no orders, and eventually regret their exit from the wave of economic globalization.

Based on the pressure of multinational companies to significantly reduce external prices, OEMs from China must adopt a strategy to reduce internal production costs if they want to continue production. However, the production costs of domestic OEMs have not seen a decline in recent years, but rather a rapid increase, which is related to the rising labor costs in China in recent years. According to the situation of China's census data, the number of China's labor force declined for the first time in 2013, and the advantage of demographic dividend as a large population country gradually disappeared, and labor costs entered a rising stage [18]. The number of people over 60 years old and the proportion of the total population in China from 2000 to 2020 are shown in Figure 8.

From the data in Figure 8, it can be seen that, in general, the number of people over 60 years of age in China from 2000 to 2020 has been rising and the proportion of the total population has also been climbing. According to the regulations, people over 60 years old can be called retirees, who

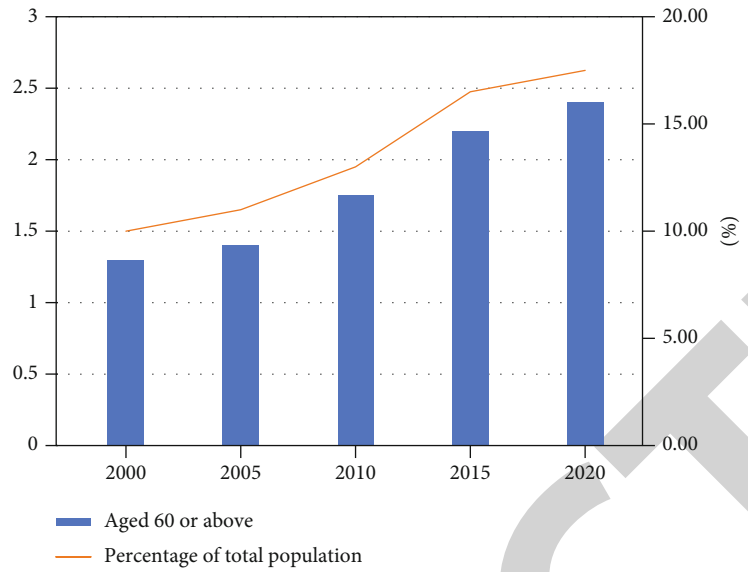

Figure 8: Trend of China's population over 60 years old, 2000-2020.

have basically lost their labor force. If the number of elderly people in a country has a high proportion of the total population, the country tends to have an aging population, which is an important factor affecting the labor cost. Therefore, the labor price of a country should be judged not only by its level of economic development, but also by the severity of its aging population. The number of people over 60 years old in China in 2020 is about 100 million more than in 2000, and the proportion rises from 10% to 16%. These figures indirectly show that the demographic dividend that helped China's economy take off before the 21st century is gradually fading, and China has entered the stage of population aging. And as labor wages naturally continue to rise, companies are forced to face greater financial pressure.

In April 2018, the State Administration of Taxation issued mandatory regulations for a new unified insurance premium collection method to be implemented starting in 2019. The new approach not only standardizes the management of social insurance premium collection but also strengthens the implementation. However, out of the need to protect their own interests, many listed companies have certain problems of omission and underpayment in paying social security premiums to their employees. Now, according to the newly introduced regulations, the above companies have to bear heavier financial pressure than before in terms of labor cost expenses. In addition, most Chinese overseas enterprises and multinational companies are at the low end of the industrial chain of economic globalization. During the production and processing of their products, they inevitably cause pollution and damage to the local environment [19]. Due to the lax regulatory penalties, enterprises often do not have to take responsibility and pay for the damage to the local environment. In 2016, with General Secretary Xi Jinping's slogan "Green water and green mountains are golden mountains," environmental management is in full swing. Companies can no longer ignore the damage to the environment, and the cost of environmental protection and treatment has become a part of the company's production costs, which have increased by a considerable amount, and in addition, this environmental management work has also driven up the price of industrial raw materials.

To sum up, Chinese overseas companies and enterprises are not only facing the loss of price advantage due to the exclusion of developed countries, but also the rising production costs are putting pressure on their assets. The shear difference caused by the superposition of the two forces has caused the profit margin of Chinese enterprises to be continuously compressed, the investment environment of enterprises has been deteriorating, and the total scale of foreign investment has been shrinking.

4.2.3. The Deterioration of Foreign Investment Environment Has Restricted the Investment of Enterprises. In recent years, according to the analysis report on global investment environment released by the World Institute of Politics and Economics, the investment environment in general is in a state of continuous deterioration globally, and the investment risk factor is growing. In 2021, total global cross-border direct investment will be $1.58 trillion, a decrease of 1.5% from 2020. The total global cross-border direct investment in 2020 has also decreased compared to 2019, and the total global cross-border investment has been in decline in the past three years. This situation is particularly evident in developed countries, where total investment by other countries in developed countries in 2020 set a five-year historical low, decreasing by 8% from 2019 compared to 2019. The decline in the level of the EU's ability to attract foreign investment is particularly pronounced. In 2021, investment in the EU by other countries and economies declined by 13% compared to 2020 and even more by 19% compared to 2019.

According to the WTO, among the three major industries, services were the largest decliners in global cross-border M&A, with a 42% decline, followed by industry with

a decline of about 18%. The decline in the total amount of mergers and acquisitions makes the inevitable product of the decline in the overall scale of cross-border investment and further indicates that the foreign investment environment is in a deteriorating state under the state of reverse globalization. The reasons for the deterioration of foreign investment environment are inseparable from the global spread of the epidemic. In the past two years, the epidemic has had a serious impact on the global political landscape and economic and financial environment, and the economic development prospects of various countries are facing various uncertainties. In order to strengthen the control of the epidemic, countries have introduced a series of mandatory measures to restrict the movement of people within and outside their borders, ensuring their national security and personal safety of their citizens, while also restricting cross-border investment activities. Under the influence of the epidemic, the projects that have been invested in cannot be started normally and smoothly, which directly affects the real income of the projects and indirectly affects the expected income in the future. The decline in expected returns will have an impact on the projects that TNCs now hold and plan to invest in the future, which in turn will have an impact on reinvestment, with the end result being a decline in the level of global cross-border investment.

In addition, the deterioration of the international investment environment caused by the epidemic is not only limited to the decline in the level of global cross-border investment, but also has an impact on the political environment, making the friction and conflict between major countries more frequent. Since the economy is the basis of international relations, the deterioration of the political environment will inevitably have an impact on the economy and trigger trade wars between countries and regions. In particular, economic and trade friction existed between China and the US before the outbreak, and the outbreak of the epidemic will only exacerbate this level of friction, thus rising to a new level. The epidemic has had varying degrees of impact on the level of economic development of countries around the world. With domestic prevention and control measures in place, the epidemic was better controlled and various economic activities were able to start smoothly, with the economy gradually recovering to its original level. However, the outbreak in the US followed, and the effectiveness of the US-China trade agreement was in a state of uncertainty. Although the epidemic did not have a direct impact on the current cross-border trade between the US and China, the possibility of the US side provoking a bigger trade dispute in the future in order to transfer its own financial crisis cannot be ruled out. Previously, the US and Europe had a frictional conflict over the epidemic [20]. President Trump announced a 30-day travel ban on Europe without consulting European countries on the grounds of stopping the epidemic in the United States. The European side said that the US act is "hegemonic and unilateral" and protested against this act. In addition, the trade conflict between the US and Europe has not come to a successful conclusion. Airbus and Boeing, as the world's two leading aviation companies, have always been in competition with each other and are inevitably in conflict with each other in terms of market occupation. The "digital service tax" has been a big issue, and no reasonable and effective solution has been found so far.

In short, the international investment environment has been deteriorating in recent years, and the investment activities of outward-oriented enterprises in this environment are seriously constrained.

5. Conclusion

This paper has provided a conceptual explanation of financing constraints and information disclosure and investigated the relationship between them and the degree of mutual influence. Through the selection of information disclosure quality indicators, a financing constraint metric model is introduced in order to expect the results of information disclosure assessment to find a reasonable idea for achieving open and transparent market information. Due to the inherent drawbacks of the market and information asymmetry on the part of financial individuals, there are inevitable cost differences between internal and external financing. Under the frictional effect of cost difference, there is inevitably a financing constraint for enterprises. This constraint cannot be eradicated, but it can be improved.

As the wave of counter-globalization continues to expand worldwide, global multilateral trade and investment rules have been greatly impacted. The outward-oriented enterprises in various countries under this wave are facing a series of investment difficulties, which seriously restrict the investment choices and investment plans of outward-oriented enterprises targeting overseas markets. In addition, the deterioration of overseas investment environment also puts such enterprises in a difficult investment situation. All kinds of investment difficulties pose a threat to the healthy development of export-oriented enterprises. In order to escape from the constraints brought by reverse globalization, export-oriented enterprises must find a transformation path that meets their own development characteristics; otherwise, they will only be swallowed by the wave of reverse globalization.

In view of the limitation of research time and personal ability, there are still some incompleteness in this paper. The relationship between financing constraints and information disclosure, as well as the investment dilemmas faced by enterprises under the wave of reverse globalization, still has many questions to be further explored and discovered.

Data Availability

The dataset is available upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Retraction

Retracted: Design of Intelligent Nursing System Based on Artificial Intelligence

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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Research Article

Design of Intelligent Nursing System Based on Artificial Intelligence

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As the number of the elderly population and the population dependency ratio increase year by year, the issue of old-age care has become the focus. However, due to the shortage of carers and the large-scale and expensive auxiliary equipment for the elderly, it is difficult to give thoughtful care to all the elderly. In view of the above background, this paper designs a set of intelligent nursing system for the elderly based on artificial intelligence (AI) algorithms, which mainly includes sensor terminals and AI processing algorithms. Among them, the sensor terminal mainly includes two parts: video monitoring and human biological signal monitoring. For video surveillance signals, this paper uses scene event detection algorithm to detect abnormal events, so as to automatically perceive possible unexpected situations. For human biological signals, such as heart rate, blood pressure, and pulse, the abnormal detection is carried out through data analysis and comparison with the normal index range. So, the possible problems in the physical state of the elderly can be judged in time. Through more comprehensive state monitoring and reliable algorithm processing, the system can effectively solve many hidden dangers in the current elderly care and provide a feasible solution for smart nursing.

1. Introduction

With the acceleration of aging in China and the increasingly complex spectrum of modern diseases, the contradiction between the increasing demand for health and the lack of medical and health resources is becoming more and more prominent [1–3]. Nurses, as the main group of people who perform treatment and preventive rehabilitation in the medical industry, play an important role in the whole process of hospital care. However, the shortage of clinical nurses has been serious for a long time. How to provide patients with high-quality and high-efficiency whole-process nursing under the condition of shortage of nurses' human resources is an urgent problem to be solved by hospital nursing managers. From the current situation, nurses often have to take care of multiple elderly people by one person [4–6]. The one-to-many care method makes the nursing staff unable to give comprehensive care to each elderly person, and it is easy to cause serious consequences such as the elderly taking wrong medicines, physical abnormalities, or accidental loss. When the nursing job is replaced, the precautions can only be simply communicated orally or in writing, which is prone to mistakes. Therefore, it is particularly important to design a smart nursing system for nursing homes that can meet the management needs of nursing homes and improve the monitoring level and management efficiency.

The current nursing home informatization system mostly focuses on the business management level and cannot solve the hidden dangers in the nursing process of the elderly. At the same time, due to the lack of human resources, there are many deficiencies in the pertinence and prevention of elderly care work. With the rapid development of artificial intelligence (AI) technology, it has played a huge role in all walks of life. In the medical and health field, AI technology has played a great role in disease diagnosis, medical image processing, biomedical signal processing, and even drug research and development. In recent years, with the development of smart medical care and medical Internet of Things, many scholars have successively proposed smart nursing system design ideas for different nursing groups, aiming to improve the automation level of nursing systems. In this context, this paper proposes a

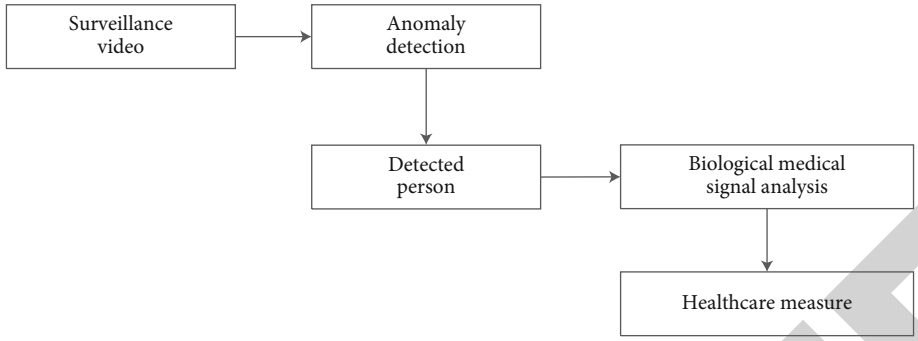

Figure 1: Basic flowchart of the proposed method.

design method of an intelligent nursing system for the elderly based on AI algorithms. This method is based on the intelligent anomaly detection algorithm and carries out targeted nursing work for the elderly by combining the two characteristics of surveillance video and biological signals. Video anomaly detection solves the problem of finding a small number of abnormal events in large scenes, mainly for the fall and bumps that may occur in the elderly. As one of the hot issues in the field of machine vision, video anomaly detection has been extensively studied, and existing methods can be classified into two categories. One is the method using handcrafted features. Such methods often use artificial features to represent events, such as object trajectory features [7–10], spatiotemporal gradients [11–13], optical flow histograms [14–17], and dynamic blending textures [18–21]. After obtaining the features representing events in this type of method, the next step is to use common machine learning models such as support vector machines (SVM) and Gaussian process models to build anomaly detection models. The second category is based on deep learning methods. Since handcrafted features are difficult to adapt to various abnormal events, researchers replace handcrafted features by using raw video frames as the input of the model through deep learning algorithms. Typical representatives of such methods are autoencoders, convolutional neural networks (CNN), long-short term memory (LSTM), generative adversarial networks (GAN), etc. [22–25]. Based on the existing researches, this paper mainly designs a video anomaly detection algorithm based on the autoencoder framework to detect the abnormal behavior of the elderly in large scenes. The method uses the improved LSTM network model to build an encoder and a decoder, which are used to learn the spatial feature representation of the video sequence and reconstruct the video sequence, respectively. Then, it performs adaptive abnormal event detection based on the reconstruction error. In terms of abnormal detection of human biological signals, data such as heart rate, blood pressure, and pulse of the elderly are collected through sensors. Based on the video anomaly detection in the previous stage, the current relevant parameters of the abnormal behavior person are compared with the data in the normal state [26, 27]. When it is found that the current measurement parameters exceed the normal range, it can be judged that the abnormal behavior person has a greater risk and prompt rescue services should be taken at this time. Depending on the severity of such situations, different levels of treatment and nursing measures can be targeted. In summary, this paper introduces AI technology and uses anomaly detection algorithm to automatically detect potential threats of the elderly, so as to provide targeted nursing and treatment services and reduce the pressure on nursing staff.

2. System Framework

The overall framework of the smart nursing system for the elderly based on AI technology is shown in Figure 1, which mainly includes two parts: sensor module and AI data processing module. The sensor module contains public surveillance video in the hospital and biomedical signal measurement equipment worn by the elderly. Video sensors mainly acquire moving images of the elderly, based on which abnormal behavior detection can be carried out to determine the elderly who may have abnormal behaviors. On the basis of video anomaly detection and positioning, the system determines the health status of the elderly with abnormal behavior according to the biomedical signal characteristics returned by the wearable detection device, such as heart rate, blood pressure, pulse, and other parameters, and then the targeted care measure can be token.

According to the AI algorithm selected in this paper, the system workflow can be summarized into the following key steps:

Step 1. Based on the real-time surveillance video, the video anomaly detection algorithm based on the autoencoder is employed to locate the abnormal events in the video and find the people with abnormal behaviors.

Step 2. For the abnormal behavior person, the biomedical signal data is obtained, and the system will judge the health status based on the historical health data.

Step 3. Based on the judgment of the abnormal behavior person's health status, the system will remind the nursing staff provide targeted rescue or nursing measures.

It can be seen from the above process that the nursing system based on AI algorithm is automatic and targeted and can achieve effective monitoring of the elderly in large

scenes at a small labor cost. Accordingly, the system can assist in carrying out targeted nursing work and has strong practical operability.

3. Method Description

3.1. Video Anomaly Detection

3.1.1. Modified LSTM. Recurrent neural network (RNN) works like a feedforward network, except that the value of its input vector is affected not only by the input vector but also by the entire input history. In theory, RNN can use information in arbitrarily long sequences. But in practical implementation, they can only go back a few steps due to vanishing gradients. To overcome this problem, a variant of RNN, the LSTM model, is introduced, as shown in Figure 2. Using this new structure, LSTM prevents the error diffusion and explosion of backpropagation so long sequences can be processed. And they can be stacked together to capture higher-order information.

In the figure, c is the cell state, which acts like an information pipeline and runs through the entire operation cycle of LSTM. The three gate structures of LSTM can delete and add information in cells, so that information can flow selectively. σ is a nonlinear activation function, which maps the output value of the function between 0 and 1, where 0 means no information passes and1 means all information passes.

The convolutional LSTM (ConvLSTM) model is an improved form of the LSTM architecture, and the matrix operation is replaced by convolution compared to the general LSTM. By using convolutions for input-to-hidden and hidden-to-hidden connections, ConvLSTM requires fewer weights and produces better spatial feature maps. The formula of the ConvLSTM unit can be summarized as follows:

$$f_t = \sigma(W_{XF} * X_t + W_{HF} * h_{t-1} + W_{CF} \circ C_{t-1} + b_F), \quad (1)$$

where f_t is the output value of the forget gate, which decides to delete or forget part of the information from the storage unit; h_{t-1} is the output value at the previous moment; X_t is the current input value; W and b are the matrix of coefficients and the vector of bias, respectively; and σ is the sigmoid activation function.

$$i_t = \sigma(W_{XI} * X_t + W_{HI} * h_{t-1} + W_{CI} \circ C_{t-1} + b_I). \quad (2)$$

Equation (2) is used to calculate the value of the input gate i_t to determine how much information to update, and the output is a value between 0 and 1.

$$C_t = f_t \circ C_{t-1} + i_t \cdot \tanh(W_{XC} * X_t + W_{HC} * h_{t-1} + b_C). \quad (3)$$

Equation (3) is used to update the cell state. The old cell state C_{t-1} is multiplied by the output value of the forget gate f_t, the output updated postselection value expression is multiplied by the input gate i_t, and the two are added to obtain the new cell state C_t.

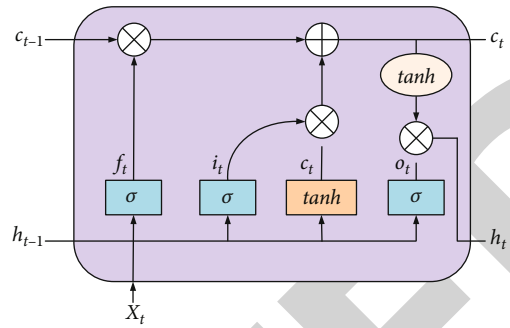

Figure 2: Internal structure of LSTM.

$$O_t = \sigma(W_{XO} * X_t + W_{HO} * h_{t-1} + W_{CO} \circ C_t + b_o). \quad (4)$$

Equation (4) is used to calculate the value of the output gate O_t, which determines how much memory is used for the output.

$$h_t = O_t \circ \tanh(C_t). \quad (5)$$

The final step is to use the hyperbolic tangent function to update the value C_t to be between -1 and 1 and multiply the output gate value O_t with it to get the final output value h_t at time t.

In the above equations, $*$ represents the convolution operation; $\circ$ represents the Hadamard product; X_t represents the input image at the moment t; i_t represents the input gate output information at the moment i_t; C_{t-1} represents the information of the memory unit at the moment $t-1$; and W_{HI} is the weight matrix from the input gate to the forget gate and so on for the rest of the matrices.

3.1.2. Detection Algorithm. The basic principle of anomaly detection method can be described as follows. When an anomaly event occurs, the current video frame will be significantly different from the previous video frame. Accordingly, an end-to-end model is trained, which consists of a spatial feature extractor and a temporal encoder-decoder that jointly learn the temporal patterns of the input video sequence. The model is only trained on videos consisting of normal scenes, with the goal of minimizing the reconstruction error between the input and output videos reconstructed by the learned model. After proper training of the model, normal videos are expected to have low reconstruction errors, while videos containing abnormal scenes are expected to have high reconstruction errors. Anomalies are adaptively detected by thresholding the error produced by each test input video.

(1) Autoencoder. Autoencoder learns regular patterns in training videos based on the autoencoder framework, which consists of two parts, namely, a spatial autoencoder for learning the spatial structure of each video frame and a temporal encoding for learning the temporal structure. The spatial encoder and decoder consist of two convolutional and deconvolutional layers, respectively, while the temporal encoder-decoder consists of a three-layer ConvLSTM model.

It takes a sequence input of length T and outputs the reconstructed input sequence. The rightmost number represents the output size of each layer. The spatial encoder takes one frame as input at a time, and after processing $T = 4$ frames, the encoding features of the T frames are concatenated into temporal encoding for motion encoding. The decoder mirrors the encoder to reconstruct the input video volume. An autoencoder consists of two parts: encoding and decoding. It reduces dimensionality by setting the number of encoder output units smaller than the input and is trained with an unsupervised backpropagation method to minimize the reconstruction error of the decoding results.

The main purpose of the convolutions in convolutional networks is to extract features from an input image. The convolutional network will automatically learn the value of the filter during the training process, but parameters such as the number, size, and number of layers of the filter need to be specified before training. As the number of filters increases, more image features can be extracted, and the recognition performance of the network becomes much better. But more filters will increase computation time and run out of memory faster, and applications need reasonable settings to achieve a balance between accuracy and speed.

(2) Reconstruction Error Calculation. The trained model can be used to obtain reconstructions of the input video sequence. The reconstruction error is represented by

$$e = \frac{1}{np}\sum_{k=1}^{n}\sum_{i=1}^{p}\left(\widehat{\theta}_{ki} - \theta_{ki}\right)^2, \tag{6}$$

where $\widehat{\theta}_{ki}$ is the output pixel value; θ_{ki} is the input pixel value; p is the total number of pixels per frame; and n is the number of frames.

A regularity score for the video can be calculated based on the error value. The regularity score normalizes the reconstruction error for each video sequence between 0 and 1. The regularity score of a sequence is given by

$$g(x) = 1 - \frac{e(x) - \min_x e(x)}{\max_x e(x)}, \tag{7}$$

where x is the output reconstruction sequence and $e(x)$ is the reconstruction error of the sequence. Video sequences containing normal events have high regularity scores because they are similar to the data used to train the model, while sequences containing abnormal events have lower regularity scores. Accordingly, abnormal events found in the video can be detected, and corresponding results can be obtained.

3.2. Biomedical Signal Abnormal Judgment Method. On the basis of anomaly detection in surveillance video, the system will automatically determine the identity of the perpetrator and then associate the person's health database. Through the health detection sensors carried by the elderly, biomedical signal characteristics such as heart rate, blood pressure, and pulse of abnormal behavior can be obtained. According to its health database, it can be determined whether the current heart rate, blood pressure, pulse, and other parameters are within its allowable range, and the physical state of the abnormal behavior person can be determined accordingly. Taking blood pressure parameters as an example, the normal range is [P1, P2] based on the analysis of the abnormal behavior health database. When the blood pressure value returned at this time exceeds the above range, it is considered that there is a risk in the physical state of the person and measures need to be taken in time. At the same time, different levels of risk, such as low risk, medium risk, and high risk, can be set according to the size of the out of range, and different solutions can be adopted accordingly. For other biomedical signal parameters, corresponding methods can be used to judge, and the final fusion decision is the corresponding risk level.

4. Conclusion

In view of the current hot issues of old age care, combined with the real background of elderly care issues, this paper applies AI technology to elderly care and designs an intelligent nursing system for the elderly. The system is based on the intelligent anomaly detection algorithm and uses the video anomaly detection algorithm to find the abnormal behavior of the elderly under video surveillance. Further, the system uses the biological signal anomaly detection method to determine the physical state of the elderly associated with the abnormal event, to determine possible unexpected situations, and to take corresponding countermeasures. With the assistance of the smart nursing system, it can greatly provide the pertinence and overall efficiency of nursing work for the elderly and effectively reduce the burden on medical staff.

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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Retraction

Retracted: An Analysis of the Influence of Complex Networks in Cross-Cultural Communication

Journal of Sensors

Received 8 August 2023; Accepted 8 August 2023; Published 9 August 2023

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Research Article

An Analysis of the Influence of Complex Networks in Cross-Cultural Communication

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With the in-depth exchanges in various aspects such as global politics, economy and trade, and cultural exchanges, improving the cultural status of the Chinese nation has become a major strategic goal of the Chinese nation. In order to better pass on Chinese culture and to truly improve the effectiveness and influence of Chinese culture in international publicity, Chinese culture needs to gradually explore effective cross-language cultural communication methods and strategies to comprehensively improve Chinese culture in cross-language cultural exchange strength on the stage of global traditional cultural exchange. On the basis of analyzing the current situation of cross-cultural communication, the article studies the promoting effect of complex networks on cross-cultural communication. The results of the article show that (1) the influence of complex networks on cultural communication is relatively significant, and the complex network communication model is used. After that, the communicative competence of the three groups has been greatly improved, and among them, the group with the rapid growth of cultural level has the greatest room for growth. (2) The point-degree centrality of organizational relationship is 10, which is relatively high, indicating that organizational relationship is in the middle position among the influencing factors, and the value orientation has a strong mediating effect. (3) The propagation efficiency of the complex network model is the highest. With the increase of the time series, the propagation efficiency will also increase. The propagation efficiency of the complex network propagation model can reach 85%. When the number of nodes is 5000, the propagation efficiency of cultural information can reach 80%.

1. Introduction

In the long development process of human history, the residents of different countries have formed different ways of thinking and cultural tendencies due to the influence of growth environment, climate, and many other factors. The difference in concept is the main reason affecting cross-cultural communication. With the deepening of global canonicalization, the economic influence between countries has gradually strengthened and a situation of cultural communication has been formed. When we leave our social circle, we will face a series of problems caused by cultural differences. In the actual communication process, we must respect the history and culture of the other country and analyze the problem with the other party's thinking, for useful information. This article investigates how national culture affects team members' perceptions of intercultural communication competence by administering a questionnaire on intercultural communication competence and high-performance teams [1]. The article describes strategies, attitudes, and survey methods to enhance the cross-cultural medical experience of patients and physicians [2]. The article examines the cultural factors that influence communication and explores how to make communication effective in a multicultural project environment [3]. The article studies how national culture affects team members' perceptions of intercultural communication competence and concludes that the hypothesized relationship and significant influence of national culture on intercultural communication competence have been confirmed [4]. This paper proposes and discusses the difficulties of intercultural communication by examining the theory and practice of intercultural

Table 1: Test content of four dimensions.

Dimension	Test content
Knowledge	Basic theory
	The relationship of culture to group representation and individual practice
Manner	Tolerant
	Respect
	Empathy
Skill	Dialectical thinking
	Articulate skills
	Relationship skills
	Self-management skills
Communicative competence	Language knowledge
	Cognitive ability
	Stylistic knowledge
	Emotional factors

Table 2: Statistics of communicative competence without complex network.

	Knowledge	Manner	Skill	Communicative competence
Rapidly growing cultural level	0.62	0.65	0.68	0.72
Fluctuating growth in literacy	0.55	0.58	0.59	0.61
Steady growth of cultural level	0.42	0.45	0.48	0.51

communication studies and also makes relevant recommendations [5]. The article argues that different ways of life constitute a tacit cultural rule or behavioral expression of a writing system, as well as understanding the way a society speaks [6]. The article discusses the effect on the smooth progress of intercultural communication and the development of attitudes between groups [7]. The article points out that multimedia, cross-cultural communication, and multimedia-based cross-cultural communication information are the key points of cross-cultural communication research [8]. This paper builds on existential phenomenological and poststructuralist concepts of heterogeneity and difference to strengthen Latinos and other underclass speakers in North-South dialogue [9]. Stereotype is an important term in intercultural communication theory and research; this paper analyzes its meaning and use from multiple perspectives and discusses its positive and negative effects in intercultural communication practice [10]. The article points out that intercultural communication is characterized by relatively high levels of effort required to reduce complexity, relatively high transaction costs, relatively low levels of trust among communication partners, and relatively narrow success conditions for generating high-risk discourse points [11]. This paper focuses on the spatial, temporal, linguistic, and cultural factors that mediate between different types of guests and the host country [12]. This paper examines cultural differences, focusing on communication processes and styles, and recommends ways to accommodate cross-cultural differences in information services [13]. This study quantitatively tested the influence of culture on direct and indirect communication as well as verbal aggression and communication anxiety [14]. Given the lack of research in this area in the unique context of the UAE, this study is aimed at identifying the types of strategies used to communicate effectively to deliver culturally competent care [15].

2. Analysis of the Influence of Cultural Communication

2.1. Research Background. In the current era of rapid global economic development, exchanges between countries are becoming more frequent. The diversification of communication involves not only economic and political exchanges, but also cross-cultural communication. Cross-cultural communication has become the work of many people. However, due to the differences of cultures of various countries, there are many problems in the process of cross-cultural communication. The cultures of various countries affect people's cognition, which is an inevitable factor. At present, most of the cultivation of cross-cultural communication in our country is limited to the teaching of cultural knowledge, rather than the cultivation of actual cultural communication skills, which leads to helplessness in the actual communication situation. The main reason for this problem is the traditional cultural differences of various countries. Because of the different growth environment and experience, people's way of thinking is also very different, and this situation is unavoidable, so we must correctly view the cultural differences between countries, in the context of respecting the cultural history of other countries, as much as possible to learn and understand the culture of other countries and learn to look at the problem with the other side's thinking. Every

Table 3: Statistics of communicative competence using complex networks.

	Knowledge	Manner	Skill	Communicative competence
Rapidly growing cultural level	0.84	0.86	0.89	0.92
Fluctuating growth in literacy	0.63	0.65	0.66	0.71
Steady growth of cultural level	0.52	0.55	0.56	0.59

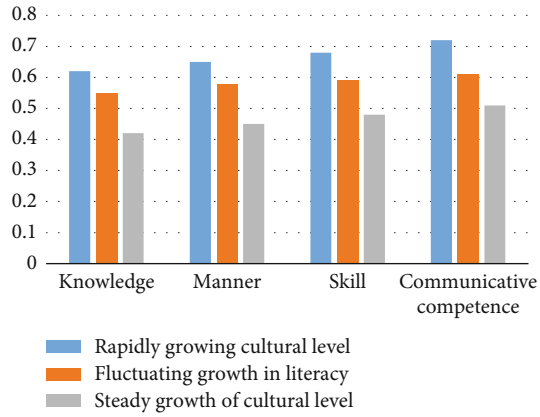

Figure 1: Statistical graph of communicative competence without complex network.

country is an independent individual, and its own culture should be respected. In the process of cultural exchange, while promoting traditional Chinese culture, respect and learn from the high-quality cultures of other countries, so that traditional Chinese culture can truly be realized.

2.2. Problems and Solutions in Cross-Cultural Communication. The Chinese nation has a history of 5000 years of civilization, and its cultural traditions are also very rich. With the gradual deepening of my country's reform and opening up, some foreign advanced civilization thoughts and concepts have also formed a considerable impact on my country's traditional culture, which has seriously inhibited the in-depth promotion of my country's traditional culture. At the same time, there are still many deficiencies in the process of spreading my country's traditional civilization to the outside world, resulting in stagnant cultural spread efficiency and management level in the environment of cross-cultural communication. The key reason for the related problems is that the development of communication culture in China is lagging behind, and at this stage, because China has entered the high-tech era, China's previous cultural communication methods have been unable to adapt to modern people's need to instantly understand the status of Chinese cultural communication and improve cultural communication. The need for strategies seriously restricts the quality and effect of Chinese cultural communication from the perspective of cross-cultural communication. My country's traditional culture not only contains some fascinating things, but also has some backward factors that cannot adapt to China's economic and social development. In the process of cultural dissemination, the effect of screening the actual information of China's cultural industry is very low, which is also a direct impact, an important manifestation of the propaganda effect of Chinese traditional culture.

For the new culture that emerges from the perspective of cross-cultural communication, the corresponding information communication media must first form the correct values for dealing with differences. In the history of world development and the entire history of world civilization, the emergence of cultural exchanges is not a one-time event, because it is a kind of human will, cognitive style, and social acceptance behavior that human beings have gradually produced in the long-term historical life. All people living in different cultural atmospheres have to go through a long historical stage before they can come into contact with other civilizations. Therefore, the way of cultural exchange and transmission is also different from the rigid development activities of human military, political, economic, and social exaggeration. Therefore, it is a soft and orderly cultural communication process, emphasizing that through immersion, talk and talk, seek development in stability, and resolutely put an end to rushing for success. Therefore, the communication and dissemination of culture is a long process. Being anxious for success and paying too much attention to economic benefits will often have the opposite effect. Cross-cultural communication ability is the performance of comprehensive ability, in order to ensure the normal progress of communication and promote the development of culture to a higher realm.

3. Establishment of Cultural Communication Model

3.1. Models of Cultural Diffusion on Complex Networks. Assuming that at the moment, individual i is a cultural spillover, and j is a knowledge receiver, and when i and j interact culturally, the growth of cultural level is expressed by the Cobb-Douglas production function:

$$\begin{cases} \triangle v_{j,t+1} = \begin{cases} 0, & v_{i,t} \le v_{j,t}, \\ A v_{j,t}^{\alpha} \left(v_{i,t} - v_{j,t}\right)^{\beta}, & v_{i,t} > v_{j,t}, \end{cases} \\ v_{j,t+1} = v_{j,t} + \Delta v_{j,t+1}. \end{cases} \tag{1}$$

When cultural individual i and cultural individual j interact, there will be a learning effect, that is, receivers with low cultural knowledge level will learn a certain amount of cultural knowledge from spillovers with high knowledge and cultural level, while the knowledge level of spillovers with high knowledge and cultural level will have a learning effect. Invariably, in fact, it is difficult to determine exactly

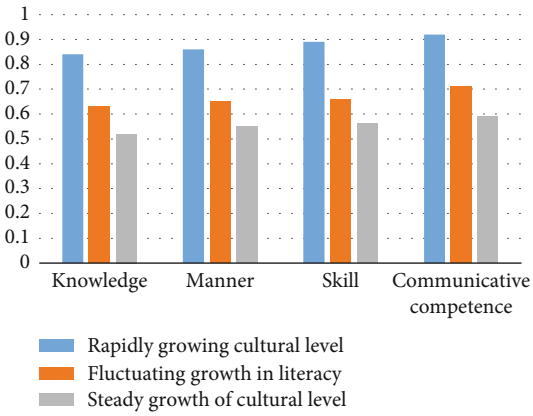

Figure 2: Statistical graph of communicative competence using complex networks.

Table 4: Calculation results of impact factor.

Factor	Mean	Variance	Standard deviation
Value orientation	3.95	0.238	0.500
Value proposition	3.70	0.499	0.480
Moral concept	3.20	0.443	0.484
Way of thinking	3.15	0.482	0.461
Basic knowledge	3.10	0.401	0.453
Organizational relationship	3.30	0.465	0.438
Ideology	3.48	0.391	0.373

how many factors play a role in the growth of cultural knowledge, but the growth of cultural knowledge must be related to the individual's existing knowledge level. If the growth of knowledge is understood as the cooperative production of knowledge, then the difference between the individual's existing knowledge level and the knowledge level of the two entities is equivalent to the two input factors of knowledge production, and the individual's existing knowledge level can measure the individual's self-effort and learning ability; the difference between the knowledge levels of the two entities can measure the knowledge spillover effect brought by the neighboring individuals.

Self-growth of individual cultural knowledge [16]

$$v_{i,t+1} = v_{i,t}(1+\lambda), 0 < \lambda < 1. \tag{2}$$

Cultural average knowledge level [17]

$$\mu_t = \frac{1}{N}\sum_{i\in V} v_{i,t}. \tag{3}$$

The standard deviation that reflects the evenness of the distribution of cultural knowledge [18]

$$\sigma_t = \sqrt{\sum_{i\in V}\frac{v_{i,t}^2}{N-\mu_t^2}}. \tag{4}$$

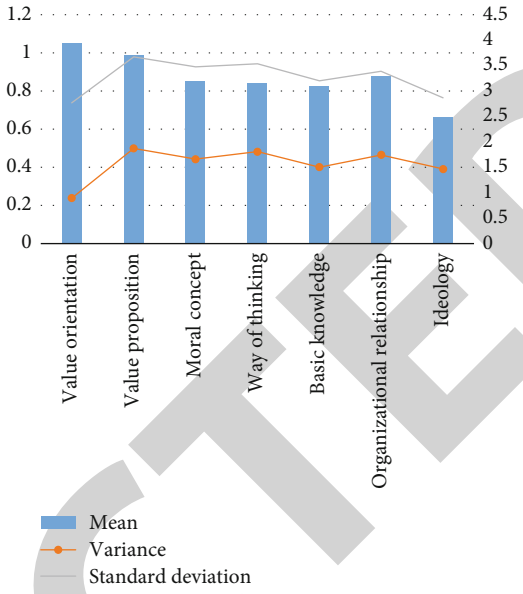

Figure 3: Exploration of the calculation results.

Each spread of cultural transmission will touch all its out-degree neighbors with probability of being immune at time t [19]:

$$p_{sr}^{i}(t) = 1-(1-\alpha)^{g(i,t)}. \tag{5}$$

The degradation probability function of cultural transmission [20]

$$\eta(t_s) = 1-\left(\frac{t_s}{t_{\min}}\right)^{-\alpha+1}. \tag{6}$$

Correlation logarithmic function [21]

$$d_\alpha(i) = d_r(i) = \log_\mu(k_i+1). \tag{7}$$

The sum of the authority of cultural communication

$$\delta(i) = \sum_{j\in ajs(i)} d_a(j). \tag{8}$$

The probability of an unknown person becoming a cultural communicator after receiving the message is as follows [22]:

$$p_{\text{is}}(i) = \theta\left(1-(1-\lambda)B\frac{\delta(i)}{d_t(i)}\right). \tag{9}$$

3.2. Analysis of Cultural Communication Mechanism. The probability that a node with degree k can receive a culture is defined as $\rho_k(t)$, and its uniform field equation is as follows [23]:

$$\frac{\partial\rho_k(t)}{\partial t} = -\rho_k(t)+\lambda k[1-\rho_k(t)]\odot(p_k(t)). \tag{10}$$

Table 5: Centrality analysis.

Factor	Point centrality	Betweenness centrality	Betweenness centrality
Value orientation	9.000	2.413	3.352
Value proposition	9.000	2.014	2.798
Moral concept	9.000	1.964	2.729
Way of thinking	6.000	1.261	1.752
Basic knowledge	6.000	1.106	1.537
Organizational relationship	10.000	0.642	0.892
Ideology	6.000	0.300	0.584

Among them, λ is the cultural transmission threshold, t is the unit time, and $\Theta(\rho_k(t))$ is the probability that any given edge is connected to the node that receives the information culture. It can be seen that the probability that the node can receive the culture is proportional to the degree of the node. Assuming that the average degree of cultural communication is $\langle k \rangle$, since the degrees of different nodes in the cultural communication network are irrelevant, the average degree $\langle k \rangle$ of the cultural information communication network will approach a stable value when the number of network nodes increases, while $\langle k^2 \rangle$ tends to a value much larger than $\langle k \rangle$, so that the spread threshold λ_c approaches 0, which indicates that information with a very low probability of culture being forwarded has the possibility of being spread on a large scale.

Steady-state value ρ_k [24]

$$\begin{aligned} \rho_k &= \frac{k\lambda\Theta(\lambda)}{1 + k\lambda\Theta(\lambda)}, \\ \Theta(\lambda) &= \frac{1}{\langle k \rangle}\sum_k kp(k)\rho_k, \\ \frac{d}{d\Theta}\left(\frac{1}{\langle k \rangle}\sum_k kp(k)\frac{\lambda k\Theta}{1 + \lambda k\Theta}\right)\Bigg|_{\Theta=0} &\geq 1, \\ \sum_k \frac{kp(k)\lambda k}{\langle k \rangle} = \frac{\langle k^2 \rangle}{\langle k \rangle}\lambda &\geq 1. \end{aligned} \tag{11}$$

Get the critical value of cultural information dissemination:

$$\lambda_c = \frac{\langle k \rangle}{\langle k^2 \rangle}. \tag{12}$$

Immune density threshold

$$g_c = 1 - \frac{\lambda_c}{\lambda}. \tag{13}$$

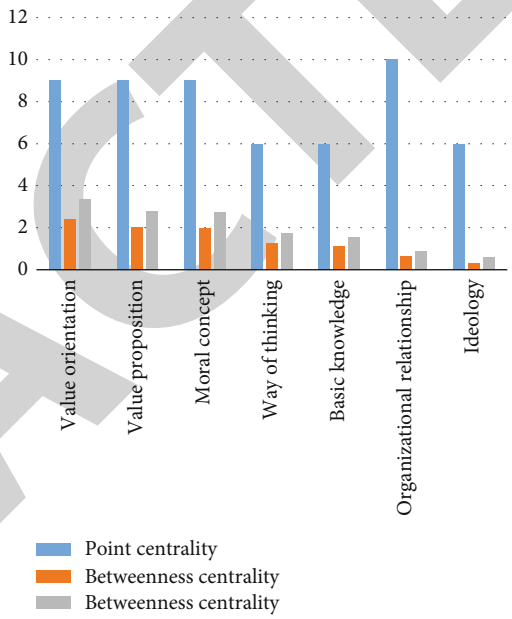

Figure 4: Centrality statistics.

Culture information node density

$$\begin{cases} \rho_g = 0 & g > g_c, \\ \rho_g = \left(\dfrac{g_c - g}{1 - g}\right) & g \leq g_c. \end{cases} \tag{14}$$

In the process of cultural information dissemination, as the number of nodes increases, $\langle k^2 \rangle$ approaches infinity, g_c approaches 1, and ρ_g approaches 1, that is, all nodes in the network will receive cultural information [25].

4. Simulation Experiments

4.1. Network Structure and Cultural Diffusion. The experiment initially constructed a cross-cultural communication model based on complex networks. In order to explore the influence analysis of complex networks in cross-cultural communication, the experiment did not consider the growth of cultural individual knowledge. Starting from the dimension, the cultural communication ability before and after using the model is compared, so as to obtain the influence of the complex network model on the promotion of cultural

Table 6: Statistics of communication breadth and efficiency.

	0	5	10	15	20
Complex network	0	60%	70%	80%	85%
Regular network	0	30%	50%	60%	65%
Random network	0	20%	30%	35%	40%

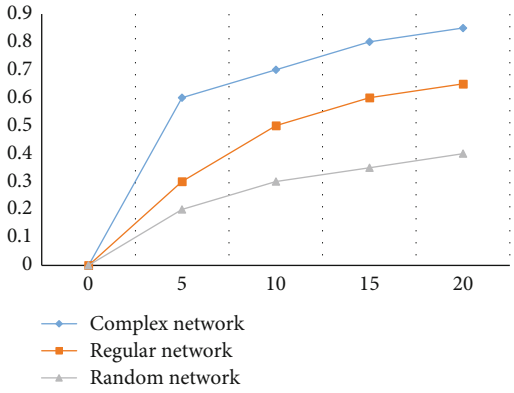

Figure 5: Statistics of spread breadth and efficiency.

communication. In the experiment, the sample data is grouped and examined from four dimensions. The experiment divides the sample data into three stages according to the level of cultural development: rapid growth of cultural level, fluctuating growth of cultural level, and stable growth of cultural level. The test contents of the four dimensions are shown in Table 1.

The statistics of cultural communication ability before and after using the model are shown in Tables 2 and 3.

According to the experimental data in Figure 1, when the complex network communication model is not used, the cultural communication skills of the three groups are relatively low. Among them, the communication skills of the fast-growing cultural level group are the highest among all the groups, with a score of 0.62 for knowledge and 0.65 for attitude. The score of skills is 0.68, the communication ability can reach 0.72, the communication ability with steady growth of education level is the lowest group, the communication ability is 0.51, and the ability of the fluctuating growth group of education level is between the highest group and the lowest group.

According to the experimental data in Figure 2, it can be concluded that after using the complex network communication model, the communication ability of the three groups has been greatly improved. It increased to 0.92, an increase of 0.2, the communicative competence of the group with fluctuating educational level increased from 0.61 to 0.71, an increase of 0.10, and the communicative competence of the group with stable educational level increased from 0.51 to 0.59, an increase of 0.80. The group with the rapid growth of cultural level has the largest growth rate and the highest communicative competence. According to the experimental results, it can be seen that the complex network model has a relatively significant effect on the promotion of cross-cultural communicative competence.

Table 7: Change trends of online cultural information of different scales.

	500	1000	2000	3000	4000	5000
Complex network	10	30	50	60	70	80
Regular network	0	10	20	35	45	60
Random network	0	5	10	15	18	20

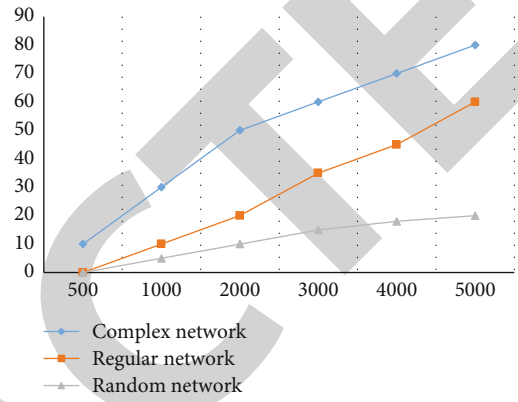

Figure 6: Statistical diagram of propagation efficiency.

4.2. Influencing Factors of Cultural Differences. In order to explore the influencing factors affecting cultural differences in various countries, the experiment will analyze cultural characteristics from multiple perspectives. In order to make the experimental data real and effective, the experiment adopts the method of questionnaire survey to study the influence of cultural differences on cultural communication. Questionnaire was used as the experimental method, 16 influencing factors were scored, and the returned questionnaires were screened to eliminate invalid questionnaires. In the statistical analysis of questionnaires, reliability and validity are important judgment indicators for measuring the reliability and authenticity of questionnaires. At present, Cronbach's coefficient is generally used to judge reliability. When the α coefficient is greater than 0.7, the reliability of the questionnaire meets the requirements, and the factors are screened and identified by calculating the mean, variance, and standard deviation of the influencing factors. The calculation results of the impact factor are shown in Table 4.

As shown in Figure 3, we can conclude that the mean of the seven influencing factors is above 3.0. Among them, the mean value of the value orientation is the largest, reaching 3.95, the mean value of the knowledge base is the smallest, which is 3.10, and the variance and standard deviation are affected. All are less than 0.5, indicating that these influencing factors selected in the experiment meet the requirements. The centrality measurement of the influencing factors is shown in Table 5.

Point degree centrality measures the number of nodes directly connected to a point in the network. The larger the value of point degree centrality, the more central the point is in the network graph. The intermediate degree is

used to measure a certain point in the network. The degree of influence between a point and other points, the larger the centrality value, the stronger the control ability of the point to other nodes.

As shown in Figure 4, the centrality of the organizational relationship is 10, which is relatively high, indicating that the organizational relationship is in the middle of the influencing factors, the centrality of the value orientation and moral concept is relatively high, and the value orientation is relatively high. The value of the relative betweenness centrality of is the largest, which can reach 3.325, indicating that the value orientation has a strong mediating effect.

4.3. Analysis of Communication Effectiveness. In order to test the effectiveness of the complex network cultural communication model, the experiment starts from two aspects of different communication efficiency and different network scales to explore the influence of complex network on cultural communication. When the communication efficiency is 1, the main research is the influence of information source selection on the speed and breadth of cultural transmission. Different propagation efficiency simulations study the propagation critical value and the sensitivity of the network to the propagation efficiency. The experiment set up three different network environments to simulate the process of cultural dissemination by randomly generating cultural information sources. The relationship between the breadth of cultural information dissemination and the efficiency of dissemination is shown in Table 6.

According to the experimental data in Figure 5, the propagation efficiency of the complex network model is the highest. When the time sequence is 20, the propagation efficiency can reach 85%. The dissemination of cultural information shows that the scope of cultural information dissemination is very wide. As the time sequence increases, the propagation efficiency will also increase, and the growth rate will become smaller and smaller and finally tends to a stable value. The propagation efficiency of the random network is the lowest, only reaching 40%, which also shows that the scope of cultural communication is relatively limited, and the propagation efficiency of the rule network is between the two.

The experiment selects cultural information dissemination networks of different scales, simulates the dissemination process of information, and verifies the relationship between network size and cultural information dissemination breadth and speed. Here, 50 networks with 500, 1000, 2000, 3000, 4000, and 5000 nodes are randomly selected, and 100 nodes are randomly selected from each network as the source of cultural information to spread cultural information. Similarly, regular networks and random networks of the same size and number are generated for comparison. It should be pointed out that the number of nodes is in the range of 500-5000. With the increase of the number of network nodes, the connections between nodes within the network increase, and the average degree of the network continues to increase. The changing trends of cultural information dissemination at different scales are shown in Table 7.

As shown in Figure 6, when the number of nodes in the cultural information dissemination network is 500, the dissemination efficiency of the complex network model is 10, and the dissemination efficiency of the other two networks is 0, indicating that the cultural information of the complex network can spread to all nodes. The diffusion efficiency of the other two networks is 0. As the number of nodes increases, the propagation efficiency will also increase. When the number of nodes is 3000, the propagation efficiency of the complex network reaches 60%. When the number of nodes is at 5000, the spread efficiency of cultural information can reach 80%, the spread efficiency of the rule network is 60%, and the spread efficiency of the random network is 20%. To sum up, complex networks will greatly improve the efficiency of cultural information dissemination.

5. Conclusion

With the improvement of China's comprehensive national strength and the integration of the world economy, exchanges between countries are becoming more frequent. However, due to different growth environments and cognitions, residents in different regions have great cultural differences. Cultural communication has caused certain difficulties. We must carry forward and spread Chinese traditional culture on the basis of respecting the cultural history of other countries. The article analyzes the promoting effect of complex network on cultural communication. The experimental results show that the promoting effect of complex network on cultural communication is quite significant. The current era is an era of economic globalization and multicultural integration. In this era of development, my country needs to conduct scientific and reasonable screening of its own cultural content and retain the essence of it and for some that are in line with the times. The development of ideas and concepts with obvious conflicts will be put to the test of history. If they cannot conform to the trend of historical development, they will inevitably be eliminated in the process of development. Cross-cultural communication ability is an important ability in the context of globalization. Improving cross-cultural communication ability will help to better integrate into the exchange and communication of world culture and create a good image of China. When conducting cross-cultural communication activities, we need to pay attention to the mutual communication, collision, and blending of different cultures. Based on Chinese culture, we choose the appropriate content of Chinese cultural cognition, adaptation, and identification and then use scientific content dissemination strategies and effective cross-cultural communication ability training, effectively balance the dissemination of Chinese culture and the integration of multiculturalism, and improve the overall quality and level of cross-cultural communication and Chinese cultural dissemination.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

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Retraction

Retracted: Applied Logic in the Age of Big Data: The Evolution of Linguistic Programming and Decoding in Psychological Trend Analysis

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] L. Liang, "Applied Logic in the Age of Big Data: The Evolution of Linguistic Programming and Decoding in Psychological Trend Analysis," *Journal of Sensors*, vol. 2022, Article ID 4915539, 12 pages, 2022.

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Research Article

Applied Logic in the Age of Big Data: The Evolution of Linguistic Programming and Decoding in Psychological Trend Analysis

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Mental health quality is closely related to individual mental health level. High mental health quality can help high school students deal with mental illness in time, actively seek help from others, and improve their stigmatized abnormal beliefs, so as to improve their overall mental health level. The party and the government pay more and more attention to the shaping of everyone's proactive social psychology, which has been widely concerned in modern society. Therefore, this article scientifically studies the applied logic of the information age: the evolution of language programming and decryption in the trend of psychological change. SQL Server data management system, Oracle big data statistical analysis and research ideas, ACSI mental health evaluation index system, and language expression encoding and decoding method were used to measure the mental health of Chinese teenagers and children, and the relevant measurement conclusions were compared. The results show that the accuracy of language programming is higher than that of traditional mental health measurement. Finally, the paper discusses the scientific research of mental health, puts forward corresponding proposals, and finally prospects the future of the exploration of the ways of mental health cultural education.

1. Introduction

The report of the 18th CPC National Congress focused on "strengthening and improving ideological and political education, paying attention to humanized services and psychological counseling, and shaping self-esteem, self-confidence, objectivity, rationality and positive social mentality". [1] The report of the 19th CPC National Congress focused on "strengthening the construction of social psychological service system and shaping self-esteem, self-confidence, objectivity, rationality and positive social mentality" [2]. It can be seen that the party and the state pay more and more attention to the shaping of people's active social psychology, which has been widely concerned in modern society. As the backbone of modern society, college students should pay more attention to humanized service and psychological counseling to reflect the necessity of the development of the times. In today's modern society, college students will face a more complex social and ecological environment and a variety of difficulties and trials. Therefore, in the new era, ideological and political education in colleges and universities has a new daily task and regularity. In recent years, positive psychology has gradually come into everyone's sight. The application of positive psychology in ideological and political education has made great progress. Please promote the independent innovation and development trend of ideological and political education to a certain extent, but for some reason, the relevant basic knowledge of positive psychology cannot reflect its real effect in the understanding and training of ideological and political education. It is necessary to improve and innovate the new important way that positive psychology is closely combined with ideological and political education [3].

As the backbone of the construction of the motherland, college students' moral cultivation level and comprehensive ability are directly related to their growth, social progress, and the country's concept of sustainable development [4]. Therefore, it is very important to do well in the ideological and political education of college students. At present, how to make college students accept excellent ideological and political education and carry out innovative development on the basis of the original ideological and political

education is an urgent problem to be solved. At the beginning of the 20th century, the development trend of positive psychology appeared in the international psychology industry [5]. Positive psychology believes that everyone must deal with the psychological problems encountered by everyone with a positive attitude and give sufficient expression, so as to discover the potential ability and excellent character of the human body, so that everyone can live a happy life. This is not only a scientific and technological innovation of traditional psychology but also injects a new energy into the ideological and political education in China and brings a new method and a new idea [6].

2. Research Background

The first definition of mental health was established at the International Academic Conference on mental health problems in 1948. The definition of the professional term "mental health" is as follows: this means that an individual's body, mood, and mentality do not dispute with other people's mental health and then adjust the individual's mental state to the best state. In this state, the body, mental state, and external environment can coexist harmoniously, but relatively speaking, this kind of state is not an "extreme" positive state. Galton Willard Allport, a famous American personality psychology expert, clearly pointed out that the influence on physical and mental health of individuals in the subconscious is relatively poor, but in order to maintain a healthy state, individuals are actually conscious and can feel and manipulate a series of external environmental energy that affect such effects [7]. Therefore, mental health can be defined as solving depression caused by external environment. Therefore, scientific research on mental health is a series of factors that affect mental health, such as depression, anger, and disappointment.

Chinese scholars ZhangChunXing and yangguoshu divided the definition of mental health into subjective and objective reasons [8]. In reality, the key to individual mental health is reflected in interpersonal communication, so it has certain social significance. Some scholars have studied the definition of "mental health" on the premise of the Confucian classic "compliance with the law." The internal and external natural environment of an individual produces a "balance state"; that is, an individual can integrate environmental factors. Tan clearly pointed out that mental health refers to an individual's psychological state of maintaining a normal, orderly, and active situation [9]. The mental health of scholars refers to that in a long period of time, individuals can ensure a long-term state of mind and recognize the value of public customary law. The characteristics of individuals in such cases are extremely charming, active life concept, excellent adaptability to the times, and expression ability. Individuals can give full play to their potential and create value. From the research of authoritative experts and scholars around the world on the definition of mental health, it can also be divided into three perspectives, including the perspective of personal improvement, the perspective of my subjective happiness and happiness, and the perspective of stress coping personality traits. Therefore, the research on mental health should also be evaluated from several perspectives and carried out in an all-round way [10].

At this stage, the references of physical health papers include a lot of research on mental health, songs, and learning music. However, there are very few articles on the harm of music courses to the physical and mental health development of college students. Only the reference research is limited to the early childhood stage, which is not common, let alone the research on college students. However, due to the development of China's economy, the level of songs has been continuously improved, the number of students learning basic music theory and musical instruments has been continuously increased, and relevant higher vocational education is still developing. At this level, there is not enough research on students' psychological state, and there is not enough research on students' work pressure and tolerance. Therefore, today's scholars cannot properly assess the damage of music class to students' work pressure and psychological state. Therefore, this research must change the applied logic of computer language and encoding and decoding in the trend of psychological state in the Internet age. Firstly, it fills the gaps in these areas. Secondly, it makes corresponding contributions to the research of psychology. Finally, it is expected that the research results in this paper can be used to promote social progress and development management decisions.

3. Materials and Methods

3.1. Basic Theory

3.1.1. Mental Health. Authoritative experts and scholars all over the world have their own views on mental health. Sigmund Freud simply regards mental health as "ability in love and work" [11]. A. H. Maslow, a social psychologist of the postmodern school, believes that mental health refers to the objective fact that individuals cannot realize themselves under the premise of considering various requirements of social and economic development, and their nature develops rapidly [12]. In China, some scholars clearly put forward that "individual psychological situation is stable and calm in long-term affairs, and can actively integrate environmental factors." Mental health refers to the acceptance of mental state, the recognition of adaptation to the new environment, the consistency and flexibility of mental state, and the relative reliability of personality psychological characteristics. These three mental health standards have long been recognized by many researchers [13].

To a large extent, mental health is based on the relevant basic theories of psychology, which means that individuals promote the development of individual personality traits according to the corresponding mental health education during their growth process, or when individuals cause psychological abnormalities and psychological problems, the outside world will educate them according to the relevant topics, correct the essential development of individuals, and prevent their own adverse effects from having the characteristics of prior intervention and subsequent compensation. The main contents and methods of mental health

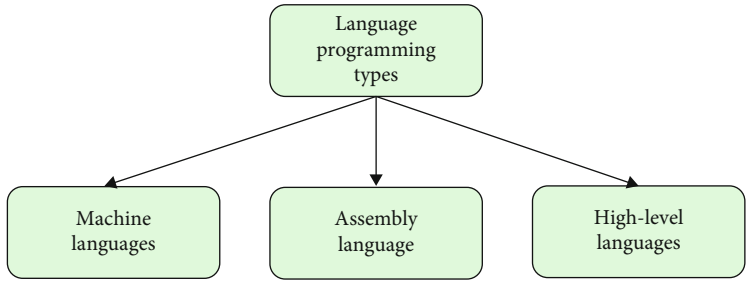

Figure 1: Types of programming languages.

management methods and manipulation can be roughly divided into the following three aspects: the first level is the adjustment of individual mentality. According to the psychological adjustment of personal internal structure, we can know ourselves again, make appropriate identification, and accept ourselves. The second level is the correct psychological state and correct guidance, that is, the essential digestion, absorption, and control of personal emotions. The third level is social research. When they feel confused about living with others, they can improve their social media professional skills through psychological counseling. The harm of scientific research music teaching to the development trend of college students' mental health is the key of scientific research in this paper. The results show that according to a large number of data, the harm of music teaching to the development trend of college students' mental health depends on improving college students' personal psychological quality, promoting the development trend of college students' mental health and physical and mental comprehensive ability in China, and giving more reference to other social psychologists and making some contributions to psychology [14].

3.1.2. Language Programming and Decoding. As a dynamic scripting language, language programming is suitable for novices without basic knowledge. It has satisfactory legibility and is conducive to novice understanding and learning. At present, with the development trend of language programming, language programming has become an important part of computer courses for students of all ages. The grammar relativity of language programming English is detailed. It can complete the software development of sentence level and object-oriented methods. Compared with other language methods, it can accurately express the logical optimization algorithm. Language programming, also known as green ecological language, is created under the background of the new era of green ecology. Its language is indirect, and it has been widely recognized. It has become the largest single language programming in the world [15].

The current situation of language programming classroom teaching has been discussed. In the classroom teaching of Chinese universities, there are differences in students' computer foundation [16]. Affected by the regional factors, some students are more familiar with the professional knowledge of computer, some have a poor understanding of computer knowledge, and some have a weak thinking ability. When they first touch the programming, their interests and hobbies are highly relative. However, due to the deep level of the discipline, students' interests and hobbies are very easy to weaken and even abandon the learning of programming courses. In the traditional classroom teaching environment, teachers pay too much attention to the course content, read articles from textbooks, and rarely shape the concept of closely combining programming and use, resulting in students' inability to broaden their horizons and promote learning, resulting in low learning efficiency and slow progress in language programming. Integrating the urgent requirements of the country for excellent talents in network information security and my professionalism, this paper intends to analyze the classroom teaching of language programming in middle school from the perspective of network security [17]. Language programming falls into three broad categories, as shown in Figure 1.

The development of teaching intelligence has positive implications for classroom teaching. In 2017, in order to grasp the key strategic opportunities of the development trend of artificial intelligence and set a precedent for the development trend of artificial intelligence in China, the State Council issued the overall plan for a new generation of artificial intelligence, which has become an explicit provision for China's strategic development. Based on this understanding, the overall planning of teenagers and children has been put on the agenda of the resolution and fully included in the content of classroom teaching courses.

Language expression programming is an important part of information technology curriculum in primary and secondary schools in China. In this course, the teacher will correctly guide students to systematically learn and train the grammar of language programming English and create programming ideas. The specific content of language programming is simple, the actual operation is convenient, and the program execution speed is faster. Learning and training according to language programming is beneficial to shaping students' ability to solve problems. Students are widely fond of information technology courses. In the study of language programming, students can design the core concepts in the program work, train the overall planning ability, and learn to solve practical problems from bottom to top, which will be beneficial to students' lifelong learning and work. With the continuous reform and innovation of the language expression programming curriculum, the curriculum has already been able to meet the learning requirements of students of different ages. In the teaching process, teachers appropriately infiltrate network security education, closely combine language programming with network security

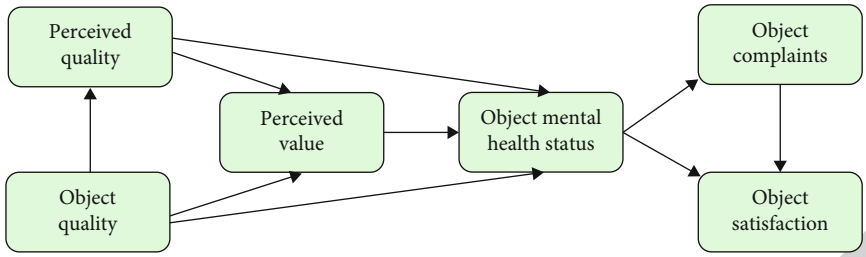

Figure 2: Evaluation model of mental health status.

education, and closely combine classroom teaching with ideological guidance, so as to help students shape network security awareness and shape students' positive and healthy life values, outlook on life and values, so as to shape China's truly qualified construction talents. In the Internet age, information content is unstoppable, and there are a variety of new development ideas. Students must have both professional knowledge and growth education who are the successors in the true sense of China's ethnic and social development.

3.1.3. Assessment Model of ACSI Mental Health. The key of ACSI physical and mental health evaluation index system is based on the acceptance of goals, and its key purpose is to measure the subjective feelings of goals on quality and service. Physical and mental health is a subjective evaluation of the service received by the experimenter or the subject. It is harmed by the cognitive definition, application, and feeling of the target individual and cannot be measured simply and directly. Therefore, some index values are designed to measure. The index value design scheme generally includes goal expectation, cognitive quality, cognitive use value, goal complaint, and goal satisfaction rate. The target expectation index value mainly includes the information obtained by the target from the outside, which will endanger the relevant quality assessment of the project acceptance products [18]. The key lies in three independent variables of index value, namely, the overall expectation of the manufacturing object on the project acceptance products; evaluate the quality of the products produced and manufactured on the production site and the needs and expectations of the production and manufacturing staff for connecting to the products. Cognitive value is the goal measured by the price given by the seller and the use value of the products received. In other words, the tooling and fixtures given by the seller are related to the product quality, and the satisfaction of the target object with the product is likely to be high; otherwise, it is likely to be low. The purpose of measuring the reporting level of the target object is to refer to dissatisfaction or the complaining attitude of the target object after accepting special products or services for a period of time. Customer loyalty honesty refers to the intention of target customers to accept products or services again after a period of time. It is also divided into three accurate measurement independent variables, that is, the probability of paying for the product or service again and whether the object wants to pay for the purchase after the price of the product rises or falls. Object satisfaction is a feeling.

Products or services are obtained according to the transaction. This feeling refers to the difference between the adoption of the product and the use value of the product manufactured by the manufacturer after receiving the product [19]. See Figure 2.

3.2. Research Methods

3.2.1. SQL Server Big Data Management System. On the basis of today's mainstream Windows and other operating system platforms, SQL Server database as a new generation of database and analysis of the processing platform software is rapidly being widely used by various enterprise customers widely accepted. Different from other database platforms such as FoxPro and smaller databases such as Access database, SQL Server has a complete powerful and easy-to-use database management and service processing functions. It is an engine that supports development, standard SQL, and other database languages and extended features such as replication, OLAP, and analysis. It is also significantly ahead of other markets in key features such as stored procedures and triggers that only large-scale database software can achieve [20].

Microsoft SQL Server 2010 is based on Microsoft SQL Server 7.0, greatly expanded to increase database performance, reliability, quality management, and ease of use. Microsoft SQL Server 2010 database edition is a high-performance enterprise relational database management system, with high reliability, ease of use, and other characteristics. SQL Server 2010 features are comprehensive and specific, as shown in Figure 3.

Therefore, this paper selects SQL Server 2010 for big data analysis. Firstly, SQL Server 2010 version has been relatively mature. Secondly, SQL Server is to manage the use of large databases, that is, to analyze the use of big data; the use of this software is more appropriate. Finally, SQL Server is a commonly used software for analyzing big data, which makes it easier for other researchers to understand the paper. Finally, the paper studies the application logic in the era of big data: the evolution of language programming and decoding in the analysis of psychological trends.

3.2.2. Oracle Big Data Analysis and Research. Oracle database intelligent management system is an associated database intelligent management system developed and designed by French Oracle Software Enterprise (Chinese name is Oracle). It may also be another Microsoft database product with distributed database design scheme as its core function. It will also become

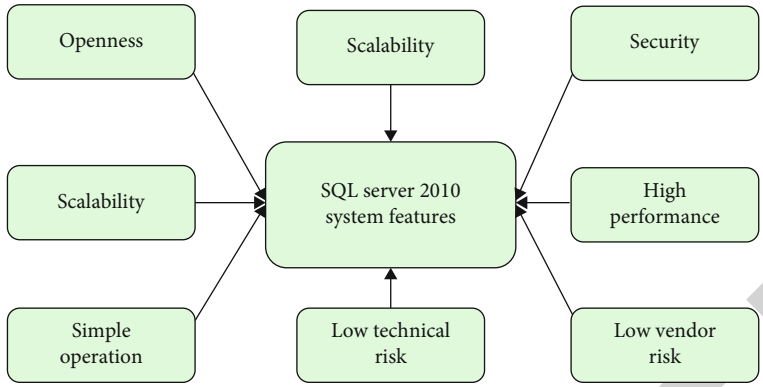

Figure 3: Main features of SQL Server 2010 system.

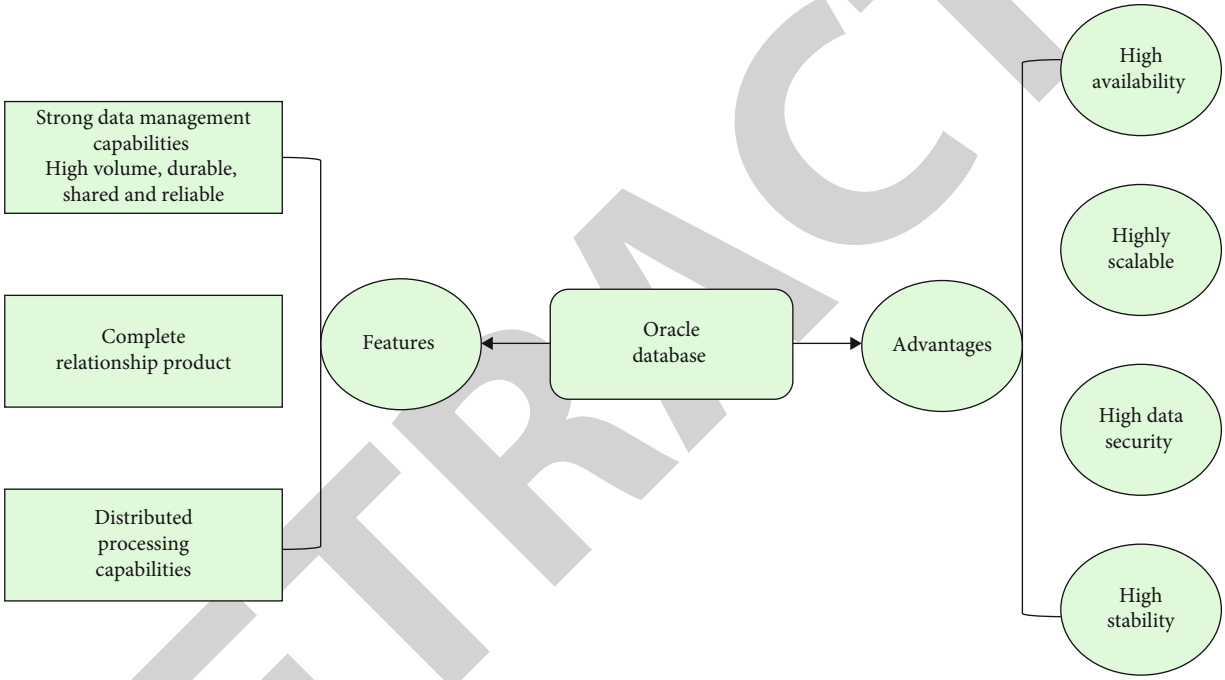

Figure 4: Features and advantages of Oracle database.

one of the most popular distributed c/s server architecture or distributed b/s database architecture solutions of Microsoft in the world. Oracle database has a common design level, such as financial institutions, telecommunications networks, mobile, airlines, commercial insurance, and e-commerce. At the same time, Oracle's products are completely free. Creators can download installation packages from their website, but their services are paid for. One of the most attractive performance advantages of the Oracle parallel processing server method is the situation view, which can dissolve all subqueries into arbitrary total subqueries and then implement the submethod on two different server CPUs. This further improves the measurement performance of multisolution system software, which should be a continuously growing information development trend in the next few years, with great potential core competitiveness. Oracle database also has other obvious advantages: detailed information storage capability, sound management features, ease of use, etc. See Figure 4.

In this paper, Oracle big data analysis language programming and decoding in the evolution of psychological trend analysis is used, for the innovative application of big data ecological management system to lay a foundation for big data processing.

3.2.3. Main Evaluation Method. In the era of big data, language programming and decoding is becoming increasingly powerful in the analysis of psychological trends. Efficient use of big data technologies in language evolution to quantify specific translation metrics can better complement and enhance research findings in the field of mental health. Therefore, this paper introduces the following neural network algorithm to measure, and the calculation formula of relevant indexes is as follows. The higher the index value is, the more obvious the trend of psychological evolution in big data technology is.

Neural network index is mainly from the two parts of the input data for processing, and the two parts are, respectively,

supervised learning and unsupervised learning. In unsupervised learning section, clustering algorithms such as K-means were used for data clustering, to obtain the center of the hidden layer radial basis function, and then, make use of information center of the width of the radial basis function vector which is calculated. The width vector can be calculated as follows:

$$\sigma_j = \frac{c_{xy}}{\sqrt{2h}}, \tag{1}$$

where c_{Xy} is the maximum distance before the center point and h is the number of nodes.

Then, the input data are correlated and dispersed through the hidden layer and output layer, respectively, and the output of the x_i input sample at the j first node of the hidden layer can be calculated by the following formula:

$$\phi(x_i, j) = \exp\left(-\frac{1}{2\sigma_j^2} x_i - c_i\right), \tag{2}$$

where c_j and σ_j are the center point and m is the width vector of the first node in the hidden layer, respectively.

The output of x_i the input sample at j first node of the output layer can be calculated by the following formula:

$$y_m = \varphi(\phi(x_i, j) * w_m), \tag{3}$$

where w_m is the node weight and φ is the activation function.

In the part of supervised learning, the key is to calculate the gradient direction value of each parameter according to the process error function in the process of changing the parameters of each level, and then use the traditional gradient descent method such as the random gradient descent method (SGD) to adjust the parameters. Please use the linear weight value at the derived layer level. For example, the upgrade formula is calculated as follows:

$$w_t = w_{t-1} - u * \frac{\sigma E}{\sigma w_{t-1}}, \tag{4}$$

where E is the error function and u is the learning rate.

The higher the neural network index, the higher the application of programming language in mental health trends. In addition to the above methods, the center point and width vectors of hidden layers can be generated randomly and then updated according to the gradient correction formula of supervised learning process.

4. Results and Discussion

4.1. Research Results and Discussion. Based on the questionnaire survey distributed to more than 10000 college students in a certain place, this scientific research applied the SQL Server database system to carry out comprehensive solutions, flexibly applied the research ideas detailed in 3.2, and carried out 90 symptom self-evaluation analysis (SCL-90) and self-rated health assessment analysis (SRHMS) on the survey report. According to the comparison with the traditional psychological calculation of programming language, the following results are obtained through comprehensive analysis.

SCL-90 is a common self-reported disease examination report in clinical medicine. For a long time, this method has been widely used in the mental health assessment of general groups all over the world. The total score of SCL-90 is 160 points, the total score of positive items is 43 points, and the total score of all elements is 2 points, which is used as the evaluation standard of mental diseases. Therefore, the application of SCL-90 in mental health assessment is objective, visual, and convenient.

Xu Jun and others developed and designed self-rated physiological health rating scale (SRHMS) for the transformation of modern medical model and health concept, which is suitable for self-rated physiological health from three aspects of physiology, psychology, and social development. However, because of the limitations of these two scales, when evaluating a group, the individual test results cannot fully reflect the health status of the subjects. In this study, two scales were used to evaluate the health status of poor students, and the relationship between them was discussed. The scale consists of 48 projects in 10 aspects, involving three aspects: physical and mental health, mental and physical health, and social health. Subjects with SRHMS score ≥ 313 were considered to be in average or good health, while subjects with SRHMS score < 313 were considered to be in poor health. SRHMS quantifies the abstract health status and allows a better comparison of mental health status. Therefore, the application of self-assessment mental and physical health appraisal scale (SRHMS) can visually and easily observe the scientific research.

According to the SCL-90 measurement conclusion, the accuracy of the application of language programming in the measurement of mental health was compared with the traditional physical and mental health measurement at the main levels of five psychological problems: somatization, coercion, interpersonal communication, depression, and anxiety ($p < 0.05$). The comparison shows that the application accuracy of language programming in psychological state measurement is more accurate than traditional measurement, and the evaluation of psychological problems is more objective and accurate. This is shown in Figure 5.

According to the Self-Reported Health Measurement Scale (SRHMS), a comprehensive comparative analysis was conducted between the language programming measure and the traditional measure in the body organ function index, positive emotion index, negative emotion index, physical health scale index, and psychosocial health scale index in cases with statistical significance, i.e., $u < 10$ and $p < 0.05$. It is found that the accuracy rate of the language programming measurement method is also much higher than the traditional measurement method in these five indices, which shows that the measurement accuracy rate will be higher in the measurement method applied by language programming, and the medical diagnosis of mental health

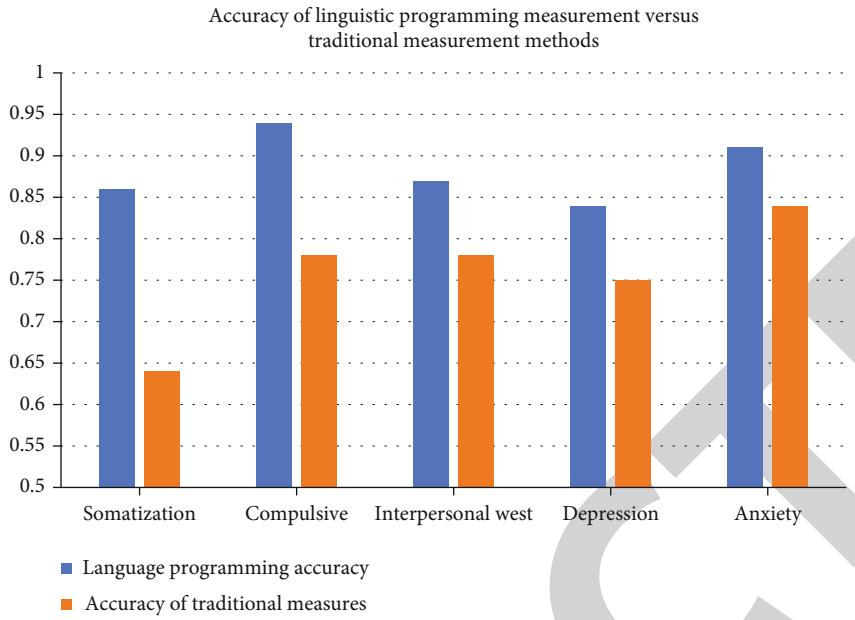

Figure 5: Comparison of the accuracy rate of the language programming measure and the traditional measure.

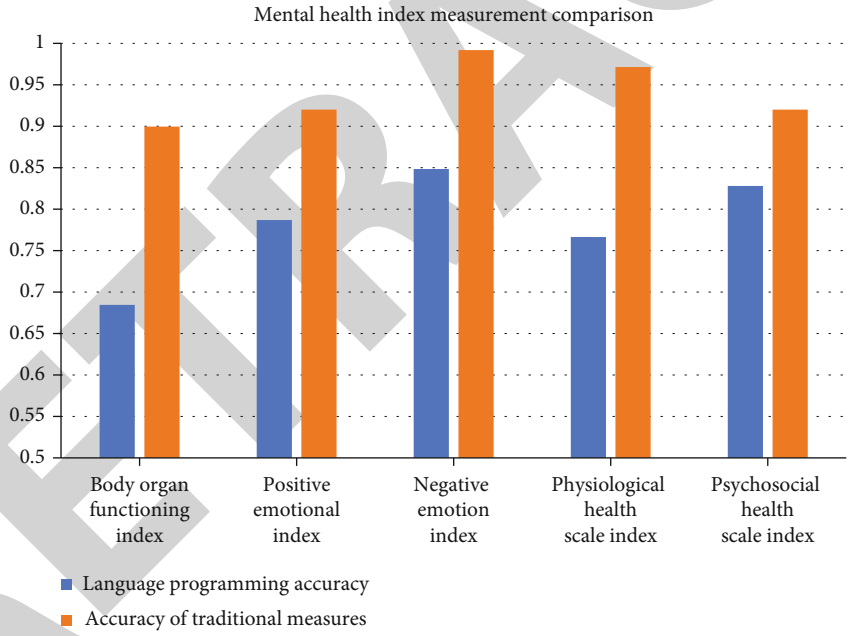

Figure 6: Comparison of the accuracy rate of mental health index between language programming and traditional measurement methods.

will be more accurate, which will be more helpful for both medical treatment and teaching. This is shown in Figure 6.

In this paper, the accuracy rate of mental health measurement is calculated based on the comprehensive measurement of SCL-90 and SRHMS, using SQL Server for data analysis, using the measurement model of mental health, three-level mental health analysis theory, and other research methods introduced in 3.2 of this paper, and conducting the comparison between traditional methods and linguistic programming methods for comprehensive mental health. The authors compared the accuracy of the two methods based on two years of iterations of the linguistic programming approach to mental assessment and the optimization of the traditional approach. It was found that the accuracy rate of the language programming measure was higher than that of the traditional measure during the two years, except for the beginning stage. This is shown in Figure 7.

In this paper, we also conducted a comprehensive statistical analysis using big data technology to compare the application rate of linguistic programming mental health measures with traditional mental health measures between 2014 and 2020 and found that as time progressed, the application rate of linguistic programming mental health measures

Figure 7: Comparison of the accuracy rates of the linguistic programming and traditional measurement methods over two years.

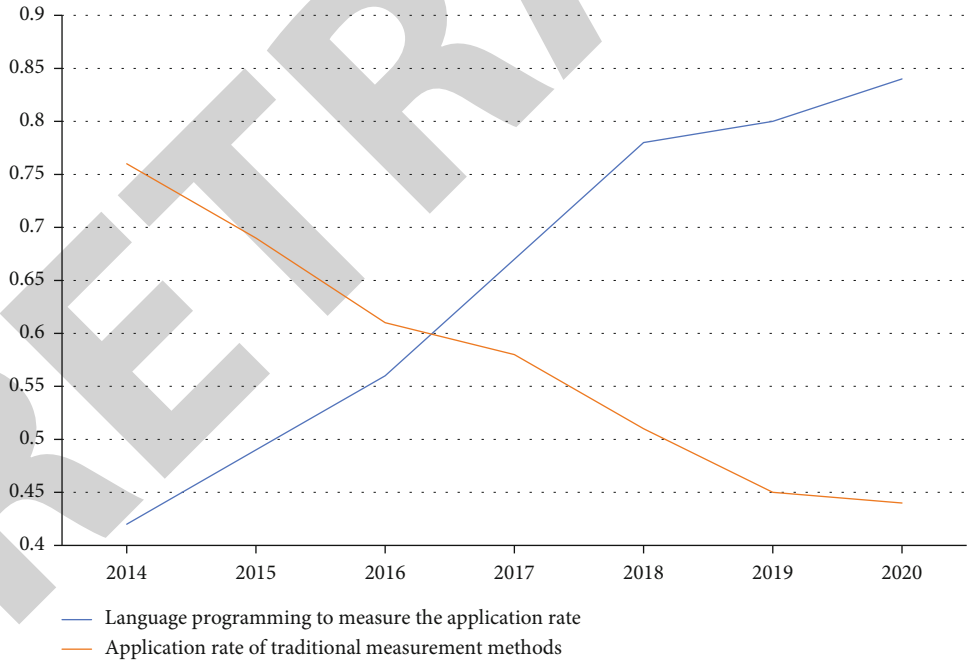

Figure 8: Comparison of the application rate of language programming measures and traditional measures.

became higher and higher due to firstly, the increasing maturity of the technology, secondly, the increasing maturity of the development of the discipline, and finally, the preference of research in the discipline for such preference for such methods. At the same time, the rate of use of traditional measures has gradually decreased. This is shown in Figure 8.

4.2. Discussion of Mental Health. According to the findings of this study, the mental health literacy level of senior high school students surveyed in this laboratory is general, and they are all worth scoring (79.05 ± 6.95). The results also show that there are individual differences and different dimensions in senior high school students' mental health

literacy. The discovery of these differences is conducive to people to pay more attention to the improvement of boys' and girls' mental health literacy. People can see from the difference of class level that the mental health literacy of junior students is relatively high, which shows that the mental health literacy is a whole process step by step, and we cannot do things in a hurry. We should fully consider this development trend when interfering with them.

In addition, family and school are the two most important daily living places for high school students, which will cause great harm to their health and progress. This scientific research investigated the harm of family driving force and school atmosphere to high school students' mental health literacy. Scientific research results show that the situation of family power devices and the school atmosphere I recognize have a significant direct impact on the mental health literacy level of high school students. If the situation of family power devices of high school students is stronger, the cognitive school atmosphere is more proactive, and their overall level of mental health and nutrition is higher. Excellent family power device is an important foundation for healthy and happy growth of individuals. Relaxed and comfortable family atmosphere, diversified thinking ability, and good family illness are attributed to the natural environment of self-development dream. Children growing up in this environment are safe in their hearts, have full emotional experience, have a harmonious and healthy psychology, and have a more active and objective understanding of mental health problems and their mental and physical health.

Patients with mental illness have less abnormal beliefs about psychosomatic diseases and patients, and they want to seek help from others immediately when encountering mental diseases, so their overall mental health literacy is improved.

With the passage of time, except for the family, the school is a relatively stable living environment for high school students. Many studies have shown that school teaching activities will harm students' mental health literacy level. In this scientific research, let us observe the school atmosphere and find that the cognitive school atmosphere will also endanger our mental health literacy. Active school atmosphere is conducive to their own mental health literacy. Conversely, if some aspects of the school's natural environment prevent students from identifying some psychological diseases, students may encounter untreated psychological diseases, endanger their own mental health development, and even lead to more serious impact. Therefore, school educators should not only strengthen the mental health education knowledge of students but also care about the influence and harm of school atmosphere on individual development, so as to create a more sufficient school atmosphere.

At the same time, when we are concerned about the harm of family and college factors to high school students' mental health literacy, we should not ignore the efficacy of students' self-efficacy in solving psychological problems. This study shows that both family driving force and college atmosphere can indirectly harm the level of mental health literacy through the sense of self-efficacy in solving psychological problems. Therefore, in order to improve the mental health literacy level of high school students, we should consider all aspects of family, college, and myself.

4.3. Suggestions for Mental Health Education. Mental health literacy is closely related to personal mental health level. High quality mental health literacy can help high school students immediately solve their mental illness, actively seek help from others, and improve the stigmatized abnormal beliefs, so as to improve the overall mental health level. This study found that the driving force at home and the atmosphere in colleges and universities can directly or indirectly harm the mental health literacy of high school students through the self-efficacy of dealing with psychological problems. The results of this analysis bring positive suggestions for improving the mental health literacy of high school students.

Firstly, there is a direct relationship between the right equipment at home and the mental health literacy of high school students. Specifically, family atmosphere, precision medicine, and disease thinking ability can significantly and actively predict and analyze the mental health literacy of high school students. Therefore, in the family, parents should first pay attention to building a simple and comfortable family atmosphere, creating good communication methods, communicating with children, and providing them with sufficient love and attention. At the same time, parents should promote the generation of "humanized" characteristics of the family, give children an indoor space with a separate development trend, and appropriately enhance the degree of emotional differentiation. If the emotional friendliness in the family is too high, it will not help the child to have a separate temperament. When he or she encounters psychological problems or mental diseases, he or she will lack rational thinking and cannot solve the problems by himself or herself, resulting in low overall mental health literacy. In addition, parents should correctly recognize and attribute mental diseases, treat patients with mental diseases as "completely creating a civilized city" rather than "completely victims," and firmly believe that their psychological adjustment can be brought into full play.

Second, there is also a direct relationship between the institutional climate and the mental health literacy of high school students.

It is also immediately related to the mental health literacy of high school students. In a word, the establishment of teacher-student relationship, partnership, and expectation can significantly predict and analyze the mental health literacy of high school students. Therefore, in schools, teachers should first pay attention to creating a good teacher-student relationship, be good at interacting with students, understand and trust each other in the case of interactive communication, treat students fairly and justly, properly handle students' problems, and provide them with great care and application. At the same time, we need to pay attention to the correct treatment of students, create a friendly and mutually supportive relationship, establish partner terminal software, flexibly use the efficiency of students, carry out interpersonal interaction activities in the teaching process,

promote collaboration and communication among students, and let students feel mutual support and encouragement. In addition, school leaders and teachers should create clear expectations for students, flexibly use "expected utility," and correctly guide students to move forward in a stronger direction. When expressing expectations to students, it is important to note that expectations should be effective and in line with students' development trends.

Third, high school students' self-efficacy in solving psychological problems plays an intermediary role among the driving force at home, the atmosphere in colleges, and mental health literacy. Therefore, the key is to improve high school students' self-efficacy in solving psychological problems. Colleges and universities can provide relevant mental health courses and learn and train ways to improve self-efficacy, such as guiding students to carry out active self-suggestion and maintain good faith. Teachers and parents should make full use of the effect of example, flexibly use the "effect of example," and improve their ability to solve psychological problems. On the contrary, it will cause hidden harm to college students. When students try to adopt some methods to solve their psychological problems, they should be immediately praised, which is also conducive to consolidating this practice and improving their confidence.

4.4. Exploring the Path of Mental Health Education. Exploring the path of mental health education cannot be achieved without the mutual cooperation of all staff and a sound and comprehensive educational elite team. Mental health education in colleges and universities must involve the participation of overall teachers, including vocational mental health education teachers, college counselors, managers, logistics service staff, and other course teachers, as well as the synergy of overall teachers, so as to improve the elite team of comprehensive education. Therefore, first of all, we should make full use of the leading position of teachers in professional psychological state. The second is to improve the efficiency of college counselors' technicians. Third is the role of mental health education for work stress management and service staff. Finally, improve the teachers' awareness of mental health education in other courses. Based on the joint efforts of all employees, we can strengthen the management of cultural and educational teams and better improve the quality of mental health education in colleges and universities.

Give full play to the psychological leading role of full-time teachers. Full-time teachers of mental health education play a leading role in mental health education in colleges and universities and undertake most of the post responsibilities of mental health education, including teaching classes, activities, information, and prevention. The full-time teachers of mental health education are not only the behavioral subjects in the classroom teaching of mental health education but also the managers who provide service information and avoid influence and the managers of publicity and education activities. Therefore, in order to give full play to the positive impact of mental health education on students and the leading role of full-time teachers of the Ministry of Education, we should give full play to the importance of physical health education.

Promote knowledge education and make full use of the effectiveness of classroom teaching. Mental health education curriculum is a practical way to spread mental health knowledge and improve students' understanding of mental health education. In order to better promote education and teaching, we should flexibly use the efficiency of classroom teaching. As full-time teachers of mental health education in colleges and universities, the vast majority of full-time teachers undertake the daily teaching tasks of the content of mental health education courses. We can start from the following aspects to make classroom teaching more useful. In terms of teaching content, it should include three levels: professional skills teaching, personal psychological experience and psychological adjustment, and be more closely connected with students' psychological problems at this stage, so as to make classroom teaching more logical. At the same time, colleges and universities can cooperate with secondary colleges to hold special lectures on mental health education close to students' daily life, which can not only enrich the teaching of course content but also provide practical basic knowledge and specific guidance for mental health education in colleges and universities, help students better learn and train practical activity skill tests, make students better understand themselves, feel satisfied with themselves, and grasp the way of self-adjustment. In the current situation of teaching, there are still some deficiencies in the teaching of mental health education in colleges and universities. For example, some teachers do not well touch the students' main situations in the teaching situations, and the classroom teaching will be boring. Some teachers only pay attention to the teaching of basic knowledge and fail to combine the methods of social practice activities of mental health education with the teaching methods of independent innovation, which makes it difficult for students to understand, and the classroom effect is not very good, resulting in students' learning obstacles.

The motivation of students' learning, training, and practicing mental health is low.

Therefore, teachers of mental health education courses must make full use of the efficacy of moral education in teaching situations, improve the reserve of basic theoretical knowledge on the premise of continuous learning, and find teaching methods suitable for themselves and students in continuous teaching practice. In order to make the mental health education courses meet the overall level of students' explanation, avoid being too advanced, and further let students feel the lasting appeal of the mental health education courses, teachers of mental health education courses will give full play to their stronger effects in mental health education in colleges and universities.

For colleges and universities, we should further standardize the mental health education curriculum, formulate the mental health education curriculum plan facing the whole process of students' learning, training, and practice, and effectively ensure the implementation. Set public compulsory courses, product series elective courses, and double bachelor's degree and double degree minor courses, fully

integrate the specific conditions of our students when setting courses, and fully cover the mental health education courses in colleges and universities, so that the systematic mental health education courses cover every stage of student enrollment. Immediately evaluate the teachers' performance and students' feedback, so as to better build the effectiveness of mental health education courses.

5. Conclusion

The report of the 18th CPC National Congress focused on the following: "we should strengthen and improve ideological and political education, attach great importance to personalized services and appropriate emotional guidance, and cultivate self-esteem, self-confidence, objectivity, rationality, and positive social mentality." The report of the 19th National Congress of the Communist Party of China focused on "strengthening the construction of social psychological service system and cultivating self-esteem, self-confidence, objectivity, rationality and positive social psychology." The party and the state pay more and more attention to cultivating everyone's all-round social mentality. The proactive social mentality has been widely concerned by modern society. Therefore, this paper scientifically studies the application logic of the Internet era from the characteristics of the times: the evolution of language programming and encoding and decoding in the changing trend of mental state. By using technologies such as SQL Server and Oracle, the mental health of Chinese adolescents and children was measured and the results were compared. The results show that the accuracy of various indicators of language programming mental health measurement exceeds the traditional mental health measurement. Finally, the paper discusses the scientific research of mental health, puts forward corresponding proposals, and finally puts forward the future prospects for the exploration of the ways of mental health cultural education.

In addition, the following methods can be used gradually. Promote knowledge education and give full play to the effectiveness of important ways of teaching classes. Mental health education curriculum is the most effective way to spread professional knowledge of mental health and improve college students' understanding of mental health culture education. Therefore, in order to better promote classroom teaching, we should make full use of the efficacy of teaching classroom.

In the campus mental health education, most of the full-time teachers undertake the daily task of teaching mental health education courses by authoritative experts. We can start from the following aspects to make classroom teaching more useful. In terms of teaching content, it should include three levels, professional skills teaching, personal psychological experience, and psychological adjustment, which is closer to the psychological problems encountered by students at this stage, making classroom teaching more logical. At the same time, colleges and universities can cooperate with secondary colleges to hold special lectures on mental health education close to students' daily life, which can not only make up for the vacancy of course teaching but also provide practical basic theory and specific guidance for mental health education in colleges and universities and help students better train their skills in learning and practical activities, so that students can better understand themselves and feel satisfied with themselves and grasp the way of self-adjustment. In the current situation of teaching, there are still some deficiencies in the teaching of mental health education in colleges and universities. For example, some teachers do not well touch the students' main situations in the teaching situations, and the classroom teaching will be boring. Some teachers only pay attention to the teaching of basic theories but do not closely combine the practice of mental health education with the teaching method of scientific and technological innovation, which makes it difficult for students to understand, and the classroom effect is not very good, resulting in low motivation for students to learn, train, and practice mental health education courses. Therefore, teachers of mental health education courses must make full use of the efficacy of virtue and talent cultivation under the teaching standards, improve the storage of basic theoretical professional knowledge according to continuous learning, and find teaching methods suitable for themselves and students.

According to the continuous teaching practice activities, make the mental health education develop rapidly, the practical Internet courses conform to the students' overall explanation level, avoid too much advance, further let the students feel the charm of the mental health education courses, and then let the students feel the charm of the mental health education courses and the charm of the teachers of the mental health education courses, so that the mental health education in colleges and universities can quickly achieve practical results.

Data Availability

The dataset is available upon request.

Conflicts of Interest

The author declares no conflicts of interest.

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Research Article

Locating Defects and Image Preprocessing: Deep Learning in Automated Tobacco Production

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Deep learning is an emerging discipline developed in recent years, which is aimed at investigating how to actively obtain multiple feature representations from data samples, rely on data-driven methods, and apply a series of nonlinear transformations to obtain reliable research results. Combined with today's development dynamics, the traditional way of cigarette production can no longer adapt to the current rate of economic development. Therefore, cigarette companies must achieve their own rapid and stable development through automation and automated management techniques for production and operation. In this paper, in the context of the research on deep learning and tobacco automation production, we focus on the application in tobacco automation production based on the management theory related to deep learning and the research method of deep convolutional neural network, mainly analyzing the application of distributed control system, production command system, logistics system, and quality control system in tobacco automation system, and conclude that the automated production system plays a role in tobacco production strengthen management and command, circumvent quality problems, save costs, and other conclusions, which hopefully have some reference.

1. Introduction

Deep learning is an emerging discipline that has been developed in recent years. Deep machine learning tools have been playing an increasingly important and unique role in various contemporary speech and video analysis techniques and various video image analysis and recognition algorithms, respectively, and are significantly changing those traditional machine learning methods in some traditional knowledge fields today, so that machines begin to mimic some visual and perceptual behavioral features inherent in the human brain itself. In recent years, the basic motivation for deep speech learning, a technological advancement in both intelligent speech recognition research and in many applications of computer vision information processing, is mainly to build a model to simulate the basic structure of neural networks in the human brain. In computer processing of various images, sound signals, and image text, the data are then interpreted by layering the semantic features of the data in multiple data transformation process stages and further illustrating with image data as an example. In the research method of the human vision system, the sequencing steps for processing these visual image signals are as follows: first, detecting image edges, initial shapes and then gradually learning to form more abstract or complex visual shapes, deep learning and combining visual low-level features so that representative features and attribute class features can be gradually learned to form complex abstract visual high-level features. As a result, deep learning has made progress in various fields, and a great technological breakthrough has been achieved in the automated production of tobacco sticks [1].

In recent years, with the rapid development of computer network communication technology and automation, companies are gradually turning to automatic production control to achieve more efficient production quality. As an important part of China's economy, the production, production efficiency, and quality of the tobacco industry directly affect the development of the entire national economy of China, and the efficiency of the tobacco industry also affects the competitive position of the tobacco enterprises themselves

in the industry. Combined with today's development trend, the traditional production method of tobacco sticks can no longer adapt to the current economic development speed. Through the automation of production and operation, automated management technology can achieve the rapid and stable development of cigarette enterprises. Therefore, cigarette enterprises should have a deep understanding of all aspects of automated production management technology, master the principles of how to do a good job of automated production management, from the process, structure, and other aspects, to achieve the automation of tobacco industry production management control. The cigarette industry is an important part of the market economy that affects the national economy, and improving the efficiency and quality of the cigarette industry can better promote the development of the national economy. Automatic control technology, as an effective way to promote the cigarette industry to a modern enterprise, is gaining more and more attention and application; therefore, it is necessary to pay attention to the construction and improvement of the automatic control system to promote the development of the cigarette industry. In the competitive context of pursuing efficiency and development, cigarette enterprises urgently need to change the traditional production and operation mode through advanced information technology, with high-tech information technology as the core, in business transformation and integration in the age of high technology. Under the guidance of implementing the concept and method of tobacco automation, tobacco companies should strengthen management, master market information, standardize and expand the scale of operation, and promote the overall progress of the tobacco industry with advanced automation [2].

In summary, it is of great research significance to study the application of deep learning in the automated production of tobacco sticks, which can improve its competitiveness in the industry for the tobacco sticks enterprises themselves and promote the progress of the whole industry for the whole tobacco sticks industry, so as to improve its contribution to the national economy and promote the development of the national economy.

2. Research Background

2.1. Research Review of Deep Learning. The technical origin of deep cognitive learning methods is from artificial neural networks. Around the middle of the 20th century, due to many major theoretical breakthroughs in the field of cognitive neuroscience, researchers have started to learn to imitate the basic structure of human brain nerve cells and initially proposed new ideas to create the theory of artificial neural networks. As the field of machine research has gradually expanded further, researchers have begun to focus more on learning how to make these machines more intelligent like other human computers. The proliferation of perceptron networks as a very special form of human artificial neural networks, which were initially not understood and fully implemented by systematic constructions, has gradually caused to stimulate later high attention to the structural aspects of neural network research. However, further in-depth experimental studies showed that the two-layer structure of perceptual learning machine networks could only be applied to prefabricated feature learning linear functions and could not be used to solve the problem of nonanalyzable linear functions. Due to the huge limitations of various theoretical foundations and research techniques at that time, the state of the art of artificial perceptual neural network theory became increasingly unpromising [3]. It was not until the 1980s that the backpropagation properties of artificial neural network data were redefined to become the focus of increasing attention today. Compared with perceptrons, BP neural network sensors have more steganographic units and can build more complex data model structures and more flexible and powerful data feature expression and processing capabilities, etc. However, due to the significant increase in the number of sensor layers, learning becomes more difficult and easily falls into local minima, and the gradient of the lower layers of the network becomes weaker. Due to these drawbacks, BP neural networks can only construct shallow learning models, which affects their scalability [4]. In recent years, many computer researchers have paid special attention to the study of deep machine learning algorithms for pairs. Izhevsk et al. also applied the technical results of deep machine learning in the field of classification of computer images and other areas to improve to the computational accuracy of classification results of images. In the field of computer speech fast recognition algorithms, Jérémy et al. advocated the use of computer deep machine learning algorithm technical results to improve the algorithmic accuracy of computer speech fast recognition methods [5]. The use of unsupervised learning models and deep learning, not only to learn image data features from image data models that can be unlabeled but also to establish parallelized image models that can be massively parallelized, points out another new direction to explore for the systematic in-depth analysis and research development of deep machine learning algorithms [6]. Among them, the most advanced representative image network target recognition residual network model, whose recognition performance, at present, has significantly exceeded the human cognitive ability. The latest voice intelligent voice response system under development by Google Inc. can easily automate more than 10% of text message response responses on the cell phone screen; the intelligent voice recognition function is better than the input accuracy of a normal keyboard, and the voice error rate is currently continuing to slowly decrease; the automatic skin cancer recognition technology is as good as the automatic skin cancer recognition system of professional clinicians. The automatic neural machine learning translation system developed by Google, Inc. is also now widely available in more than 10 other computer language programs. There are many more examples of such applications. Such maturity models could eventually allow the application of these maturity models to a large number of corporate customers and to people's lives in the future [7].

2.2. Review of Research on Automated Tobacco Production. In recent years, research on automated production has covered a wide range of areas, such as production planning

management, production scheduling management, and production management aspects of the cigarette industry as well. The details are summarized as follows: National Sun Yat-sen University, Chen Zhixiang thesis, based mainly on fuzzy control theory analysis, studied the fuzzy demand lead time theory and fuzzy demand-driven production process planning theory and production control theory model for tobacco automation, researched to how to improve the dynamic flexibility of the master production control plan management in MRPII system, and pointed out that the current master production. It is pointed out that the current MRPII system lacks the dynamic response of the system, and two main improvement measures are proposed to improve the dynamic response flexibility of the MRPII system by improving the flexibility of the MRPII system design, introducing the design concepts of both demand flexibility and supply response flexibility in the production planning system, and further giving a corresponding algorithm model [8]. The paper by Ruan et al. is based on an empirical study of the key strategic issues of how to effectively determine the strategic development of a modern tobacco enterprise that is developing in complex dynamic, stochastic, and fuzzy management environment conditions, to develop an effective and reasonable medium- and long-term planning plan, and to ensure the successful achievement of the overall long-term planning objectives. Using the theoretical analysis of dynamic stochastic and fuzzy development theory, a model of strategic multistage dynamic development of modern tobacco business operation was constructed and improved [9]. For the technical characteristics of centralized production and scheduling management in China's continuous production tobacco and production industry, Riman et al. proposed the establishment of a production management process structure that applies a network model for analytical modeling and solving, respectively, and further elaborated and improved the management strategy for the design and implementation of the scheduling automation system for continuous tobacco and production enterprises, based on the requirements of the basic production operation methods developed in the continuous production process industry at home and abroad and the technology market characteristics, proposed a summary of the four main basic models of continuous production control process optimization in enterprises [10]. On the other hand, Ding Feng from Tsinghua University used the optimization methods of "process optimization" and "system optimization" to systematically study the local optimization design problem of the design of the scheduling optimization system for the continuous tobacco production process, and tried to feed the simulation results of the whole system design optimization back to the process model in time to guide the optimization idea of the local equipment scheduling optimization system and explore the creation of another new design problem. The effective method of the problem opens up a new development of ideas for realizing the problem of comprehensive system scheduling optimization of large-scale industrial production system design, giving an analysis of the theoretical framework structure of production command scheduling large system design, the principle basis of system optimization technology for large system design and practical application design examples [11]. Xu Zhi and Han Bing, in Shanghai Jiaotong University, worked out a scheduling optimization problem of continuous production earliest completion time index with cigarette segment production task constraint and buffer constraint effects, which effectively and quickly converts an original complex scheduling problem into another linear production planning problem by integer form of constraint and continuous production time as the computation center form of constraint [12].

In summary, deep learning and automated tobacco production both have a lot of research content and research results, and this paper is developed based on the previous research.

3. Research Methods and Materials

3.1. Main Concepts and Theories

3.1.1. Deep Learning Concept. The principle of deep mining distributed machine learning is to extract some underlying data features by using multiple data hidden layers; each hidden layer is equivalent to only one data perceptron, which can obviously and effectively alleviate the minimum problem of underlying data locally. The depth of the extracted underlying data features can be obtained by using a data perceptron to extract some low-level features and then by recombining all these underlying features to form some more complex and abstract representations of the high-level data, which is a representation of distributed deep learning features [13].

3.1.2. Classification Applications of Deep Learning. The model of deep learning can be said to be composed of several semantic level models together, which has many unique functional advantages of many kinds of deep semantic learning tools; that is, at the same time, it has a strong autonomous semantic autonomous learning ability, efficient and fast parallel massive data feature extraction and natural language expression and processing analysis ability. Therefore, the deep learning system can soon be widely recognized by domestic enterprises for applications in intelligent image feature recognition, speech recognition, face intelligence recognition, video semantic analysis, and data information mining and collation. Therefore, this deep learning system can be quickly applied to intelligent image feature recognition, speech recognition, face intelligent recognition, video semantic analysis, and data information mining and collation, etc., which are widely recognized by domestic enterprises [14].

(1) Speech Recognition. The hybrid Gaussian statistical model system (GMM) system has long been used as a probabilistic model to describe the Gaussian statistics among individual modeling units [15]. Due to the advantage of simplicity of estimation theory and the effective support of more mature and stable technical systems such as language recognition and training, this Gaussian model theory has long been kept in the leading position of international monopoly in the practical application technology of speech recognition. However, the hybrid Gaussian model is still

essentially structured as a shallow network, which cannot really describe the state space distribution among semantic features adequately and effectively [16]. In addition, in the process of GMM speech modeling, the feature model dimensional model is usually only a few tens of dimensions, and the deep neural network is used to simulate, human brain multilayer analysis results in the gradual extraction of various information features, forming a more complete and ideal information features suitable for pattern classification research. This human brain multilayer analysis structure has a considerable high degree of information similarity with the simulated human brain analysis in computer processing of various speech data and video image information. In the Baidu speech recognition system, DNN algorithm is used for speech recognition modeling, and compared with the traditional GMM speech recognition system modeling method currently used in China, the corresponding speech error rate is reduced to about 25%. In November 2012, the first enterprise speech information search and service application system based entirely on DNN technology was officially launched, becoming one of the first professional technology companies in the international industry that can formally use DNN information search service technology for enterprise speech information search service products [17]. The flow of speech recognition is shown in Figure 1 below.

(2) Image Recognition. Image recognition algorithm is one of the first typical applications of computer deep image learning theory proposed for the system. In this model called Hinton, the input object is only considered to be a single face pixel corresponding to a natural image feature, without considering any other kind of artificial features involved and used [18]. In 2012, Baidu Maps has successfully and innovatively tried to explore and apply mapping technology based on deep machine learning methods to achieve accurate recognition of real-time face pixels in the presence of natural image features and finally successfully launched a Baidu Maps search tool product based on its technology accordingly [19]. In 2013, deep machine learning, models, and computation have been successfully and effectively and widely applied to the study of deep recognition and understanding of natural language image data and advanced natural language analysis and understanding. The successful application of deep machine learning technology in computer image recognition algorithm analysis can not only directly and effectively improve the recognition and algorithm accuracy of computer images but also completely avoid sacrificing the huge consumption of time resources for manual computation due to the manual extraction process of large amount of manual image feature information, thus effectively and greatly improving. The efficiency of online image algorithms and computational analysis is greatly improved. The deep learning algorithm will probably replace the existing manual feature learning method and machine learning method in the future and become a mainstream development in the field of intelligent image feature recognition processing technology [20]. The process of face recognition is shown in Figure 2 below.

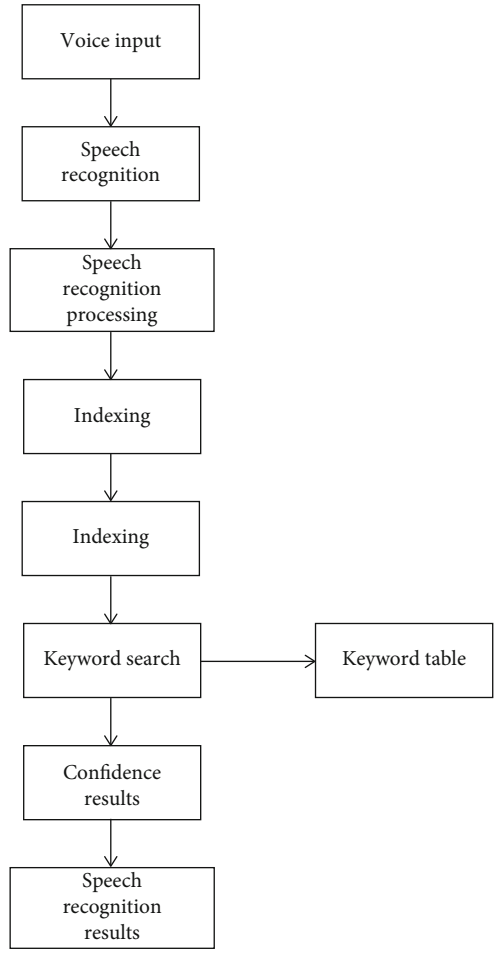

Figure 1: Speech recognition flow chart.

(3) Natural Language Processing. Another emerging application and area of deep machine learning research may be natural language analysis processing (NLP). In recent decades, artificial neural network models based on statistical analysis seem to have gradually become the mainstream of today's neural network theory, but there has been very little systematic research on artificial neural network theory in the field of neural networks as such a statistical inference method alone. The world's first work on deep machine learning for NLP problems was done entirely in the laboratory, and the research and development organization started to use embedded systems and multilayer one-dimensional convolutional structures to solve the most typical NLP problems simultaneously in 2008, including the same model they used for people of different backgrounds, which could achieve a very high accuracy rate.However, the great progress that has been made in the analysis of deep semantic learning of natural language based on NLP algorithms has not been as impressive as in the processing of audio images.

3.1.3. Common Deep Neural Networks. The neural network model mainly uses a deep machine learning model as the core of the hidden layer Markov model, and the input feature data information can be processed and extracted from multiple

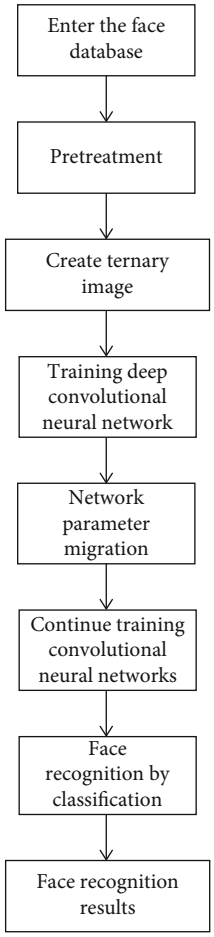

Figure 2: Face recognition flow chart.

hidden layer models layer by layer at the same time, so that a series of feature data mappings containing different levels of feature data can be generated, and then, these mappings can also be extracted from the underlying data of the network at the same time. The more general network feature information extracted from the underlying network data can then be connected or combined with some other mappings that require deeper abstraction to extract higher-level network features, thus enabling the network model itself to have another way to better learn to extract data and learn to express the feature mapping information. The classical deep neural network model with three hidden layers is shown in Figure 3 below.

Because the number of hidden layers involved in complex deep neural network layers is often too large, the number of parameters that need to be learned and processed in depth are larger, and there may even be new and old problems in the computational process and design practice of learning and training analysis, so now people are engaged in the analysis of modeling and construction of complex or deep complex neural network system layers. The deeper the neural network level, the more difficult it is to optimize and compute. Therefore, it is still very difficult and complicated to train from scratch until a deeper neural network model is created and finally to guarantee the good computational performance of the neuronal network model itself. Hinton et al. finally decided to divide the whole training process into two most important parts, the main process of previewing the training results and the fine-tuning process. Through the use of such networks and training, these problems have been solved by a very mature and effective technique, and since then, in-depth research has started and more and more senior researchers in the field are starting to use it, and a wave of research is coming. As the research related to computerized deep machine learning theory has been carried out in further stages in recent years, people have gradually developed various computerized deep neural network models including various types of different structural forms in the face of these complex problems that require multiple data types at different levels and cross depths between different technical fields for research verification.

3.2. Research Methodology. The following is a description of the convolutional neural network used on this paper.

The convolutional neural network role is mainly that it can significantly reduce the complexity of the algorithm for solving complex model problems, not only can effectively maintain a most complete deep and complete model structure of the model itself but also actually therefore greatly reduce the redundant some weight parameters in the model itself, so that the model can be more with a strong good generalization and analysis ability. The two major advantages are that the image CNN technology can simultaneously use all the individual pixels of an image as input, and at least one filter signal must be used between each pixel convolution layer signal to interact with other image input signals to help determine the image features needed after obtaining the original image input data. This allows the system to continuously and repeatedly extract and compute the basic image features needed for the image input and then to progressively extract and transform the subsequent image features into higher-order image features. The training process also makes use of a specially integrated image feature extraction engine and image classifier, which can easily and repeatedly extract various image features that can be effectively combined, avoiding a large amount of complex feature engineering. Therefore, the CNN structure can be generally regarded as a multilayer perceptron that refers to an image with a relatively stable special structure, allowing only the scaling, translation amplitude, and rotation direction of any point of the image to be relatively stable or constant. The simplest and most common CNN structure usually consists of a cascade of image hiding layers with different functional characteristics, which are first assumed to be just one image convolution layer, then an image pooling layer, repeated several times until the image output is reduced to a sufficiently narrow image size, and finally, an image cascade structure is usually added to help regain an image output that appears to be completely unconnected and unrelated. An image cascade structure that appears to be completely unconnected and unrelated is added to help regain an image output.

(1) Convolutional layers

Once the mapping of image features is quickly extracted by the convolutional layer method, in principle we can also

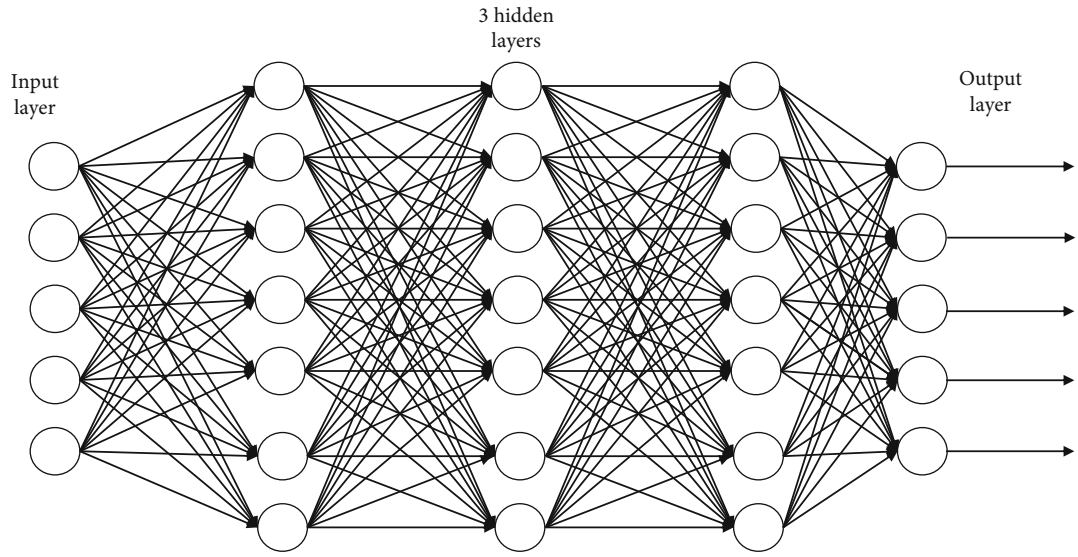

Figure 3: Deep neural network model with three hidden layers.

quickly use the mapping information as input information for further training of the image classifier function. However, there may still be a lot of redundant information in the image feature mapping process. In order to minimize these redundancies, a new pooling layer (downsampling layer) is added. Different convolutional kernels can extract different features of the image. In order to get the complete and effective features of the sample image, multiple convolutional kernels are usually chosen, such as 64, 128, and 256. The size of the convolution kernel determines the size of the feature image, and the step size of the convolution kernel determines the step size and the number of features. That is, when the input size of the convolution process is $W_1 \times H_1 \times D_1$, the output feature image size $W_2 \times H_2 \times D_2$ is, P is the zero-complement size,strideis thekernel – sizestep size, is the sizeoutputof the filter, is the number of filters, calculated as follows:

$$W_2 = \frac{W_1 - \text{kernel} - \text{size} + 2P}{\text{stride}} + 1, \tag{1}$$

$$H_2 = \frac{H_1 - \text{kernel} - \text{size} + 2P}{\text{stride}} + 1, \tag{2}$$

$$D_2 = \text{output}. \tag{3}$$

(2) Pooling layer

After extracting image features through the convolution layer, in principle, these features can be directly used as input for classifier training. However, there may be redundant information in the feature mapping at this point. To reduce these interferences, we add a pooling layer (downsampling layer). The pooling layer reduces the dimensionality of the convolutional layer data and reduces the number of parameters and computation. It can effectively prevent overfitting. It also tolerates slight distortion of the model with translation invariance and rotation invariance. There are three types of pools: max pool, average pool, and random pool, also using windows to move through the input graph. The difference between the three convergence methods is in the calculation of the window values. The maximum pool is the maximum value, the average pool is the average of the fast subsampling elements, and the random pool is a random value calculated by its probability. Pooling is also a special kind of convolution kernel, but the difference is that the pooling layer acts on regions of the image that do not overlap. Given the convergence function under the direction, the whole process of the descent sampling layer can be described as follows:

$$X_K^{(l+1)} = f\left(w^{(l+1)} \times \text{down}(R_K) + b^{(l+1)}\right). \tag{4}$$

(3) Activation function

Each layer in a CNN can have some kind of activation function that accepts the product of the input and the weights, except for the input layer. CNN uses the activation function to select the features extracted from the network in a nonlinear mapping way to avoid the problem of inadequate expression of linear operations. In practical applications, the common activation functions can be divided into saturated nonlinear functions and nonsaturated nonlinear functions.

(4) Softmax layer

After extracting the image features, to use these advanced features for classification, then a regression model is required, and the most commonly used is the Softmax regression model. It is improved on the basis of logistics and is mainly used to solve the problem of multiclassification of data.

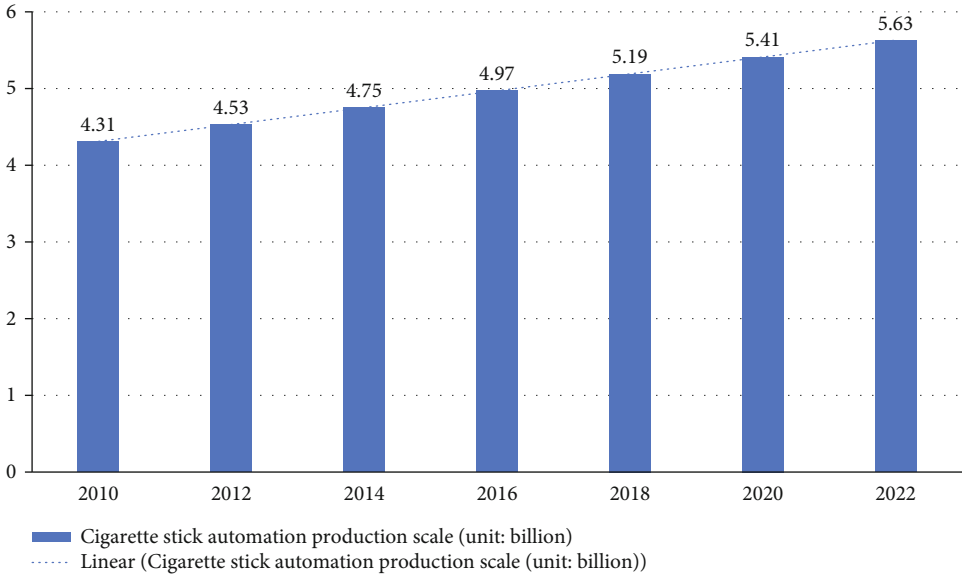

Figure 4: 2010 to 2022, the scale of automated cigarette production.

4. Results and Discussion

4.1. Research Results. The following points were analyzed by deep learning theory algorithm and deep convolutional neural network.

(1) The scale of automated production of cigarettes gradually increases, as seen from the Figure, the scale of automated production of cigarettes in 2010 was 431 million times, 453 million times in 2012, 475 million times in 2014, 497 million times in 2016, 519 million times in 2018, 541 million times in 2020, and 563 million times in 2022, with the gradual increase of automated production, the scale of automated production also gradually increases, the scale of cigarette production and operation increases, and the production efficiency increases significantly, as shown in Figure 4

(2) Compared with traditional cigarette production, the market share of automated cigarette production is also increasing year by year, with traditional cigarette production accounting for 63% and automated cigarette production accounting for 37% in 2010; traditional cigarette production accounting for 58% and automated cigarette production accounting for 42% in 2012; traditional cigarette production accounting for 50% and automated cigarette production accounting for 50% in 2014; and in 2016 Traditional cigarette production accounted for 44% and automated cigarette production accounted for 56%; in 2018, traditional cigarette production accounted for 38% and automated cigarette production accounted for 63%; in 2020, traditional cigarette production accounted for 31% and automated cigarette production accounted for 69%; in 2022, traditional cigarette production accounted for 25% and automated cigarette production accounted for 76%, it can be seen that in 2014, automated cigarette production and traditional production occupy the same market share, and after 2014, the scale of automated production exceeds the scale of traditional production of cigarettes, and the proportion of automation in the production of cigarettes gradually increases and occupies the main share, as shown in Figure 5

(3) Distributed control system application in tobacco automation production: assuming a full score of 10 for employee efficiency and performance, it can be seen that 5.5 before and 7.51 after application of distributed control system in 2010, 5.7 before and 7.82 after application of distributed control system in 2012, 5.8 before and 8.13 after application of distributed control system in 2014, 2016 5.97 before and 8.44 after the application of distributed control system, 6.12 before and 8.75 after the application of distributed control system in 2018, 6.27 before and 9.06 after the application of distributed control system in 2020, and 6.42 before and 9.37 after the application of distributed control system in 2022; thus, the data shows that the efficiency and performance of employees in a distributed control system The data shows that the efficiency and performance of employees are significantly improved after the application of distributed control system and nearly full score. The management system effectively connects the tobacco shop and the management center through the existing network technology and eventually achieves remote control, thus promoting more effective management of the tobacco shop. This requires computer processing technology, control technology, communication technology, computer technology, and control table technology as a whole to build the management system. This automated

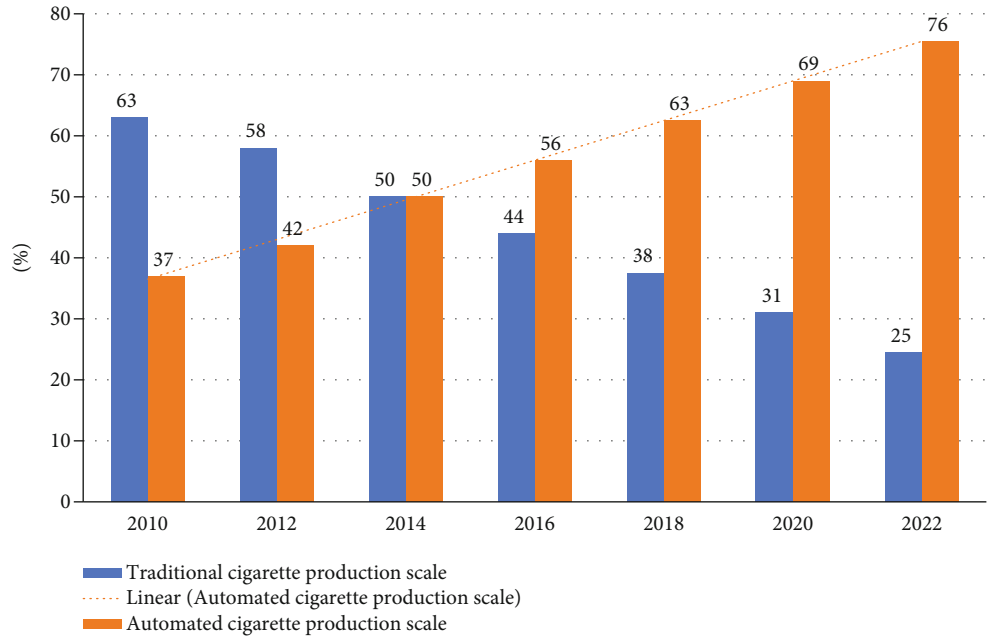

Figure 5: Comparison of traditional and automated cigarette production scale from 2010 to 2022.

system control model allows for timely and effective management of the production site through remote control supervision even when workers are not in the workshop, in order to reduce production costs, improve management efficiency, and enhance the quality of tobacco production and management, as shown in Figure 6

(4) Production command system: the cost of tobacco production and operation in 2010 was 432 million yuan, the cost of tobacco production and operation in 2012 was 425 million yuan, the cost of tobacco production and operation in 2014 was 418 million yuan, the cost of tobacco production and operation in 2016 was 411 million yuan, the cost of tobacco production and operation in 2018 was 404 million yuan, and the cost of tobacco production and operation in 2020 was 397 million yuan. In 2022, the tobacco production and operation cost will be 390 million yuan, and the production cost will be reduced continuously, which can be applied to the production and management of the whole process of tobacco production control, to provide comprehensive tracking service for tobacco production and management, and to form a complete report for guiding and optimizing tobacco production activities through the collection and analysis of tobacco production workshop site data, so as to accurately grasp the production process command system in the production process to reduce the occurrence of error rate and ensure the production efficiency of the tobacco industry. At present, the production automation command and decision system can be effectively used for the whole tobacco industrial production and control system under the whole business process of control production scheduling and operation management, the most comprehensive and accurate production tracking and scheduling services for all tobacco field production operation and enterprise management personnel, by realizing the timely information collection and analysis of each tobacco and production processing workshop operation field operation data, forming a complete scientific operational report for real-time guidance monitoring and dynamic optimization of various tobacco enterprise production operation activities, so as to accurately grasp the production process command system, reduce the occurrence of error rates, and ensure the productivity of the tobacco industry, as shown in Figure 7

(5) Compared with the use of traditional production methods, such as agricultural mechanized production logistics system, automated agricultural logistics system can help more effective and low-cost efficient savings in farm human resources costs and labor costs and improve the utilization of agricultural land resources elements. The application of automated warehousing logistics system in cigarette enterprises can give full play to the advantages of networking, automation, intelligence, and informationization. In the traditional cigarette system, the supply of 230 million and the demand of 340 million exceed the demand, and the supply of 340 million and the demand of 340 million in the automated logistics system can reach the state of supply and demand balance, as shown in Figure 8

(6) There are many competitors in the cigarette industry, and the competitive pressure is great. To develop in the severe environment, it is necessary to strictly

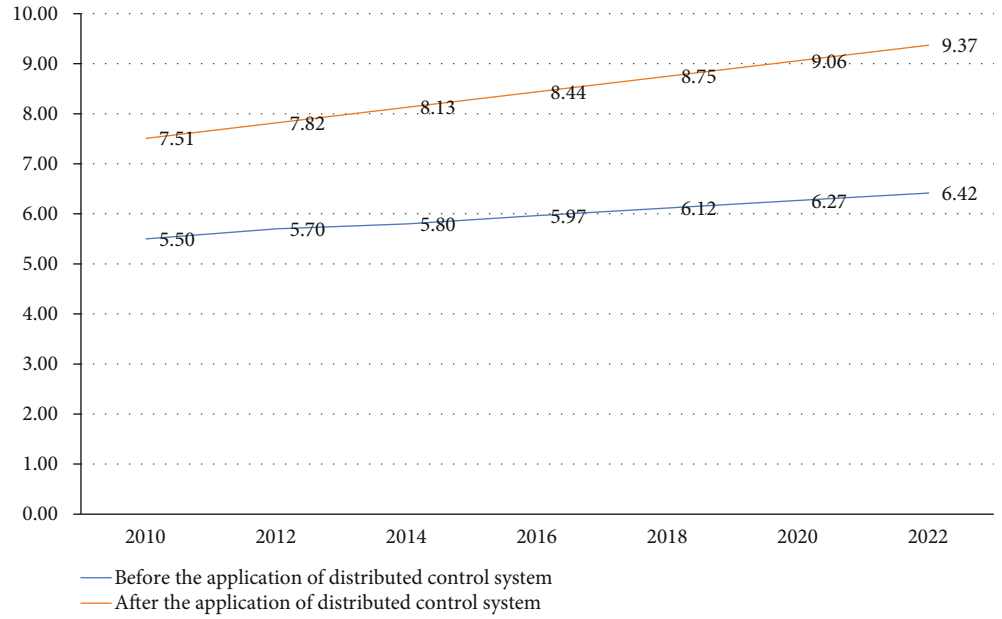

Figure 6: Distributed control system before and after the application of the salt worker efficiency ratio and performance comparison chart.

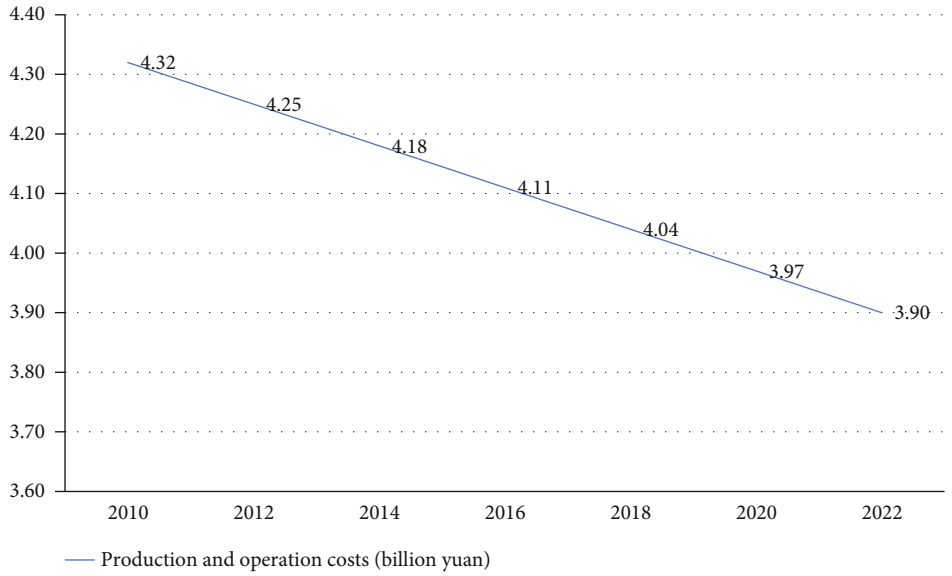

Figure 7: Automation joined the change of production and operation cost of cigarette enterprises.

control quality, ensure quality, and extend management automation to all aspects of quality control. Therefore, managers should set up tobacco quality evaluation standards in advance and put forward detailed requirements in terms of production process, standardization, institutionalization, networking, and strict enforcement. On the other hand, the automatic tobacco quality control network is established in factories and warehouses, forming a strong automatic control network that improves control transparency and provides real-time information on the quality of tobacco preparation, production, and logistics. For example, information can be collected, transmitted, processed, and fed back in a timely manner for special cases, such as loss of dried materials, damage to manually operated items, incomplete packaging, etc., so that managers can easily identify problems and make corresponding adjustments and treatments in a timely manner. The number of quality accidents in cigarette production was significantly reduced after automation was added: 15 in 2010, 13 in 2012, 10 in 2014, 8 in 2016, 5 in 2018, 3 in 2020, and 1 in 2023, which shows that the addition of automation in the

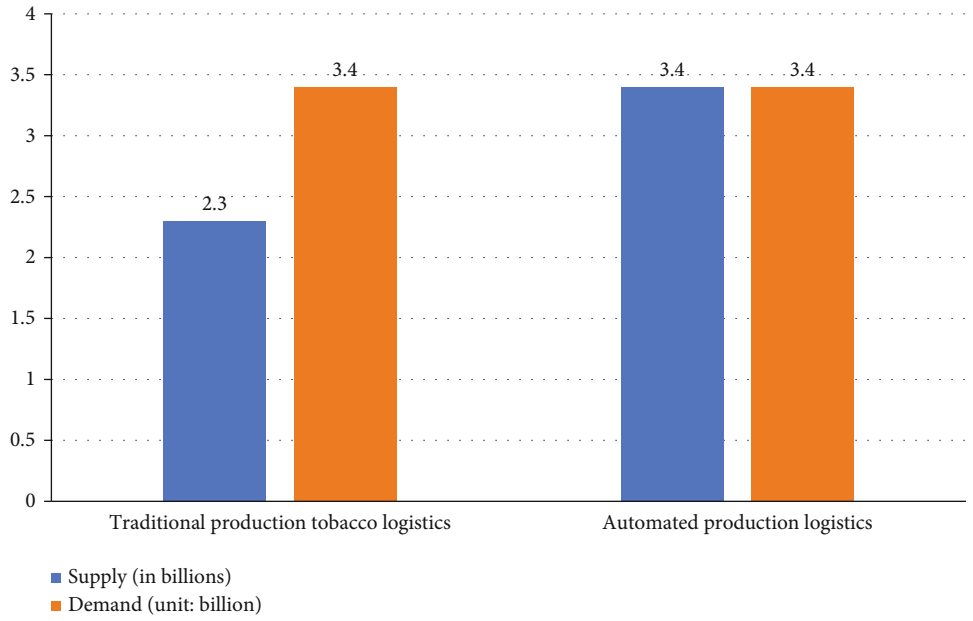

Figure 8: Traditional logistics and automated logistics supply and demand comparison chart.

production process is more standardized and intelligent, which reduces the probability of quality problems and controls quality problems to each link, as shown in Figure 9

4.2. Analysis of Results

(1) Current status of tobacco automation production: at present, tobacco automation has been widely used in China's tobacco machinery. It is widely used in packing, silk making, leaf beating, rebaking, automation, and other machinery and equipment. Threshing and machinery of preloading is obtained and the packaging has fully realize automation operation, but the operation is obtained using air separation equipment, although many equipment manufacturers go through innovation, imitation, and mapping method to improve the technology and has a certain technical strength, but in self-control and wind separation technology level, there is still a gap with the international technology. The machine also adopts advanced production lines from Germany, Italy, and other countries to improve the automation degree of tobacco production machinery and equipment. YanZhi commonly used mechanical automation control technology, frequency conversion technology, servo technology and fieldbus technology, control equipment mainly includes the rich, Siemens, mitsubishi, panasonic, omron, etc., frequency conversion equipment is mainly including Siemens, danfoss mixer by yaskawa servo technologies such as controller, panasonic, Bosch company ,and Siemens equipment technology. In terms of bus, it is mainly used in man-machine interface, valve island technology, special language, image processing, and robot technology. In view of the automation YanZhi production machinery and equipment, advanced equipment and technology applied to YanZhi production, from relay logic controller to the PLC control, the centralized monitoring, to the integrated management and control of automatic control device, these changes fully embodies the YanZhi mechanical technology advances, formed with the core of robots, PLC, and servo automation infrastructure. The middle management has also realized information, and the upper decision-making has also realized intelligence, forming a three-layer intelligent network structure. Some tobacco enterprises apply advanced fine processing technology and equipment to realize the design of fine processing and product production, and realize intelligent control and cost saving

(2) Existing problems: in recent years, the application of Profinet technology in the field of tobacco production has been promoted. With the progress of technology, Profinet technology is gradually developing towards the direction of high automation, wireless network, low cost, and low energy consumption. However, although China's tobacco machinery and equipment technology continues to progress, but the application of tobacco automation in the production of tobacco enterprises is not extensive; some cigarette automation application is not mature, seriously affecting the intelligent and efficiency of tobacco production. Especially in automatic control equipment, sensor is the key technology, widely used in YanZhi production equipment, but the sensor technology in China is not very sensitive and cannot fast access to relevant information; therefore, YanZhi

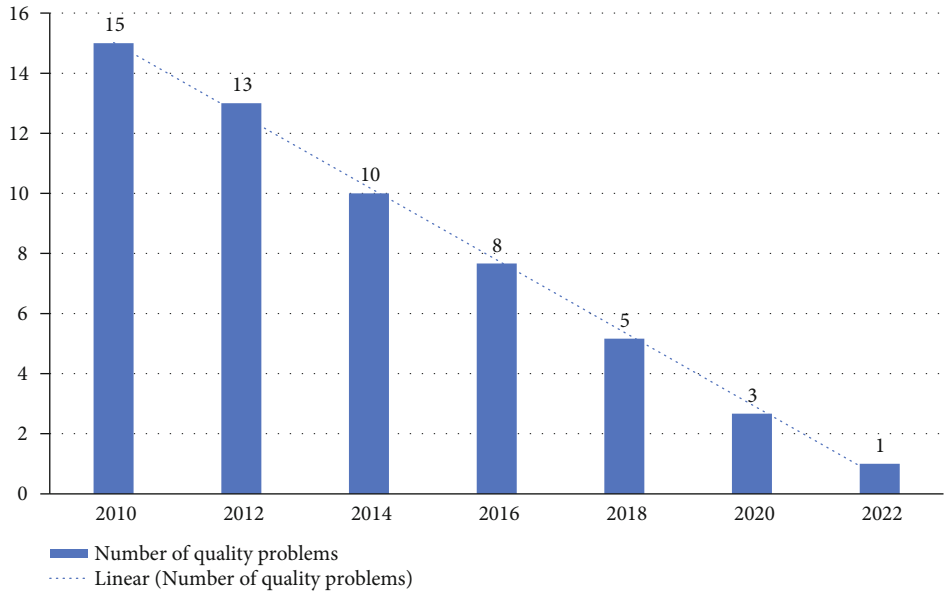

Figure 9: Graph of changes in the number of quality problems in automated production.

production equipment parameters cannot be timely transferred to the control system of information transmission delay significantly reduces the effect of intelligent control. At the same time, its automatic control performance is relatively low, the selection of automatic control system is not consistent with the actual production, the stability of the actual operation of the monitoring system, and network communication system is relatively poor, prone to failure, resulting in cigarette production efficiency and quality decline, to bring huge economic losses to the enterprise. In addition, the automation industry continues to develop, the automation of tobacco production equipment to constantly upgrade and optimize. However, some tobacco production enterprises can not advance and can not properly upgrade and optimize the automatic control equipment, resulting in a low degree of automation of their technical equipment

(3) Measures: tobacco production enterprises should attach importance to the application value of automation, timely introduce advanced automation technology, and improve the intelligent level of production. In particular, PLC and Profinet technology should be actively introduced and applied to improve the level of equipment intelligence. At the same time, it is necessary to optimize the production process and the design of several production lines, especially the automatic control device in the production line, to ensure the stability of its operation, and to carry out comprehensive management of all links of tobacco production, to achieve real-time monitoring of production. In the automatic equipment of the tobacco production system, the internal structure should be optimized constantly, and the quality of equipment, process, and products should be tested regularly to improve the production quality. Of course, this operation and quality inspection is mainly carried out through the use of sensors, detectors, and other automatic devices. The control system of tobacco production equipment can complete various operations according to the instructions of sensing information to ensure that the production quality meets the production requirements. Optimize the internal structure, improve the sensitivity and accuracy of detectors, sensors, and other equipment, and effectively improve the quality and efficiency of production, saving production costs. In addition, we should pay more attention to the training of technicians so that they can operate the relevant technical equipment effectively. With the progress and development of automation technology, its application in YanZhi production equipment is changing, needs regular training of operating personnel and management personnel, makes them master relevant technical knowledge and management, and improves the level of operation, to ensure that YanZhi production equipment automation function can timely and effectively deal with the problems existing in the equipment operation. In a word, the application of automation in tobacco production equipment can effectively improve its production efficiency and quality and effectively reduce the production cost of enterprises. However, tobacco production enterprises should pay attention to the application of automation and personnel training to ensure the smooth progress of automation

5. Conclusion

Based on the correlation tube theory of deep learning and deep convolutional neural network, this paper focuses on the application of tobacco automatic production and draws the following conclusions:

(1) In the process of automatic control design of tobacco industry, we should start from the standards of system design to ensure the communication between automation system and various business systems and external systems. Generally speaking, the specification of automatic control system for tobacco production management needs to be realized from the aspects of internal and external interface, internal program design, module interface, and system user interface

(2) The principle of flexibility and expansibility of the automatic control system of production management in tobacco industry is mainly aimed at the function and performance of the system. The application of the automation system can be adapted to different production operators and facilitate the development and expansion of other production systems. As long as the production management control system of the cigarette industry always ensures the principle of flexibility and scalability, the scale expansion of the cigarette enterprise in the development process will not be limited by the system, thus providing a guarantee for the development of the cigarette enterprise

(3) The design of the production management automation control system in the tobacco industry should adhere to the principles of reliability and operability. In the production and management process of tobacco industry, the automatic control system should have strong stability, safety, and reliability, and each functional module to realize its own process, with certain tolerance according to the requirements of each functional module, which will not cause problems for each functional module with other functional modules. In addition, the system should be easy for operators to manage, the system operation interface automation, application system clear and concise, and easy to manage and use

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Retraction

Retracted: Deep Integration of Rasch Model and English Classroom: Language Teaching Development under Information Technology

Journal of Sensors

Received 23 January 2024; Accepted 23 January 2024; Published 24 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] J. Yan, "Deep Integration of Rasch Model and English Classroom: Language Teaching Development under Information Technology," *Journal of Sensors*, vol. 2022, Article ID 3744678, 11 pages, 2022.

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Research Article

Deep Integration of Rasch Model and English Classroom: Language Teaching Development under Information Technology

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The informatization of education is an important part of the industrialized informatization of our country and an inevitable path for the development of contemporary education. The development of informatization as well as industrialization is driving the changes of the times and the continuous innovation of people's way of thinking, living habits, and educational methods. The continuous innovation of computer technology and the widespread use and popularization of various classroom methods of English teaching have led to the continuous optimization and upgrading of English teaching at the higher education level in China. However, with the rapid spread of university education and the varying levels of English teaching in higher education institutions, there are a series of problems that need to be solved in the process of transformation of information technology teaching. Therefore, this paper examines the deep integration of the Rasch model and the English classroom from a practical context: language teaching development under information technology. Through an in-depth discussion of theories such as language teaching and information technology development, the development of language teaching in China's English classrooms is studied using the Rasch model analysis method. It is concluded that our teachers' English teaching methods are relatively backward, not sufficiently matched with the current needs of our students, and the teaching methods are relatively homogeneous. And based on the problems, it is proposed that firstly, educators should have objective information literacy and orientation criteria; secondly, high-quality and content-rich English training units should be developed to facilitate implementation; and finally, suggestions are made to promote the development of information materials in the context of teaching practice.

1. Introduction

The development of the times indicates that the direction of education is inevitably informatization [1]. Informatization of education is an important part of industrialization informatization in China, an inevitable path for the development of contemporary education. The development of informatization as well as industrialization drives the change of the times and the continuous innovation of people's way of thinking, living habits, and educational methods. Since the 21st century, English teaching in schools and colleges in China has been continuously promoting the implementation of informatization. The continuous innovation of computer technology and the widespread use of various classroom methods of English teaching have led to the optimization and upgrading of English teaching at the higher education level in China. However, the rapid spread of university education and the varying levels of English teaching in higher education institutions have led to a series of urgent problems in university English teaching in the process of transformation of information technology teaching [2].

With the continuous development of China's economy over the years, the demand for industrial informatization in China is increasing, and the application of modern information technology such as computer technology and new network technology is becoming more and more widespread, which helps to introduce information methods and teaching materials into education. The emergence and high level of utilization of teaching methods under the conditions of informatization shows a trend of innovation under the conditions of the increasing level of teaching technology and the increasingly widespread use of computers.

According to the trends and tendencies of the educational era, the rational and flexible use of multimedia networks and information teaching in computers to support educational reforms will help to improve teaching effectiveness and promote the spirit of modern education [3]. In the process of teaching college English, teachers should make more use of information technology and modern teaching methods and techniques to introduce and express teaching contents and teaching concepts more comprehensively and to reflect modern educational ideas based on language use. In order to improve the quality and efficiency of college English teaching, it should be more student-centered [4].

The continuous changes in the information age have gradually given rise to the information-based education model, which is a teaching model and a new learning method based on the continuous development of computer technology and the innovation of information technology [5]. With the basic conditions of modern information technology, information-based teaching exists in the design concept and related teaching practices. Effective use of modern information technology and Internet big data processing technology to achieve effective integration of English teaching in colleges and universities with contemporary information technology is a key project in the current construction of higher education institutions in China. In this paper, we analyze the main features in English teaching in colleges and universities in the left and put forward the outlook of information-based English teaching according to the current needs of Internet teaching [6]. This paper focuses on the principles of integration, theoretical basis, current situation, and effectiveness of English teaching in higher education institutions under the information technology environment. The perspective of this paper begins with the practice related to informational teaching, further investigates the important methods and basic principles of realizing informational teaching, and based on the research, provides some outlooks and reflections on the informationalization of English teaching [7].

Higher education institutions should keep abreast of the times in carrying out informatization teaching reform, have a global vision and holistic concept, further study and explore new cutting-edge teaching solutions, fully consider and use information technology in the practical exploration of English teaching reform, use information technology to promote the modernization of English teaching in colleges and universities, and continuously move in the new direction of informatization of English education [8].

2. Research Background

2.1. Status of Foreign Research. Education informatization, as an important initiative of the national long-term education development strategy, is an important way to improve national competitiveness. Some professional bodies believe that it is necessary to ensure that the national strategy for sustainable development becomes an integral part of the national strategy for sustainable development information. Implementation of national strategies to implement information reform and innovation strategies [9].

The Royal University is guided by its strategic vision, innovation, and practice in information education, by its high-quality education and comprehensive national orientation. Information about the working environment and market resources is available on the ECE website and participates in the development of human resources in the field of information training. At the same time, it uses and combines its deployment environment to raise awareness of information infrastructure and SLA documentation development issues. Development and full utilization of global resources and programs at the national level. In the field of computer mediation in the UK, the National Optimization Application Network is the center of information mediation and application. In Australia, the teaching and learning model has been largely computerized in all regions of the country to a level of full network coverage. The Australian government has established regular curriculum, teaching quality control, and language teaching performance control in all schools offering foreign language courses and language training through a strong and diverse production network. Optimization of design capacity, validation management, and assessment [10] were done. At the same time, the network will help teachers and educators at all levels of the education system to provide information services, to exchange information between Australia and the world, and to enter a new national and global information age. As the largest political issue in the world, the United States uses and exploits the results of information technology education. In the United States, more and more schools and universities are involved in the use of information. They are using information technology for export and lifelong learning after studying practical student problems, learning international law, and referring law enforcement agencies. School networks in the United States are very popular. They use information technology to introduce advanced equipment and facilities that have been widely used without discrimination, which is an important adaptation for the society [11].

2.2. Status of Domestic Research. Along with the continuous development of industrial information, the informationization of modern education in China is facing new challenges and new path options [12]. The informatization of education in the contemporary world is developing rapidly and has made certain achievements. Modern distance education networks, Chinese educational and scientific research computer platforms, and satellite broadband multimedia transmission platforms have been formed and realized to interface with educational satellite networks. They all have interactive functions, and the modern distance education interactive network platform is based on the satellite video system. The contemporary modern information education based on the Internet platform is carried out under the system of satellites. In our country, modern information technology and network technologies are gradually replacing the traditional face-to-face teaching methods. In the whole world trend, the information-based teaching mode replacing the traditional teaching mode is a big trend today.

According to a survey conducted by the National Bureau of Statistics, more than 90% of higher education institutions

in China have built campus networks. The multimedia equipment and related network facilities in higher education institutions have been greatly improved. The laboratory buildings, teaching buildings, libraries, and administrative buildings in higher education institutions can form an organic whole, well, unified together to form a high-level networked teaching with all the advantages of contemporary networked English teaching. Colleges and universities should strengthen the infrastructure construction of networked teaching and related training, build modern multimedia classrooms and multifunctional language classrooms, and laboratory-related network construction platforms, to improve the overall level of English networked teaching and hardware equipment to the world class [13].

In English teaching in most higher education institutions in China, English teachers use as many teaching methods as possible in combination with student learning to enrich English classroom teaching [14]. On the way to creating courseware and English education, teaching content and learning methods can be imparted and expressed in the form of multimedia devices. The fact that English teachers can choose their own English teaching materials is a major feature of English teaching in our universities, which helps to expand students' knowledge. In the actual classroom, English teachers should further encourage students to participate in scenario simulations and related role plays to demonstrate their understanding of information resources in situational interactions. This will allow students to experience the necessary and available language knowledge and skills required for targeted exploration and consolidation in their future careers [15].

Through the above analysis, both in countries with more advanced education abroad and at home, information-based education is constantly permeating contemporary educational concepts and is being carried out in practice. In the context of our government's vigorous promotion of education modernization, China's realization of informatization education can refer to some more advanced modern education concepts as well as informatization models [16]. Compared with countries with better development of education informatization, China has some commonality with the world's model in terms of implementation means and other aspects, but there are characteristics of backward infrastructure and uneven development levels among regions in China. Therefore, the process of modernizing and industrializing informationization of English teaching in China is not ideal enough, and there are constraints such as teachers' inability to reasonably allocate and use modern information technology means, the overall database construction level is not high, the combination of network technology and English teaching is not comprehensive enough, and the quality of learning platforms as well as network resources is low to extremely low. All of them reflect that the level of modern information technology in China is not as good as it should be. Therefore, in solving this problem, we must first understand the characteristics of modernized information technology education, and secondly, we must accurately grasp the basic conditions of English teaching in China, so that we can use it to our advantage and develop the advantages of information technology, in order to promote the development of China's education informatization towards a more desirable direction [17].

3. Materials and Methods

3.1. Basic Theory

3.1.1. English Language Teaching. College English is an English language course for non-English majors. It is an important basic course that almost all college students take. It used to be called public English. Since 1986, the Chinese Association of Public Foreign Language Education changed its name to the Chinese Association of University Foreign Language Teaching and Research. Since the founding of New China, especially in the last 30 years, English teaching in higher education has been innovated in many ways such as common teaching materials, research content, learning philosophy, and many other aspects. The most important elements play an important role in teaching English in universities and incorporate some web skills to make computer programming more integrated into the university curriculum [18].

Starting 30 years ago, slides were used in the teaching of general higher education, where foreign languages were taught for the first time with audiovisual teaching of foreign languages, and from the 1920s to the 1940s, tools related to radio, audiovisual, and recording were continuously put into teaching. There were also new developments in language teaching in English classes in higher education. New audiovisual methods have appeared in Europe and the United States since the middle of the last century, especially in France in the 1950s, where slides, films, and other audiovisual teaching materials were widely used to organize listening and speaking exercises, thus combining sound images with visual images and in the context of global sound perception and foreign language structure. Thus, foreign language audiovisual instruction has a history of several decades [19].

In the last 30 years, in the context of modern information technologies, foreign language teaching has entered a new phase of information exchange in foreign languages. Since the 1980s, computer-generated language materials have appeared, enabling students to improve their language with the help of computers. At the same time, computer language learning is a new field of applied linguistics. With the rapid development of modern information technology and further development of information, learning information through computer networks and multimedia is an inevitable trend in the development of education. Of course, in addition to the need and preparation of technological prerequisites related to teaching English at the university level, there is a constant need to make these changes. There are two main reasons for this: First, there is a growing demand for international English language workers. The importance of English as a cross-cultural international lingua franca is unquestionable as China's sustainable development, driven by economic globalization, cannot be achieved without cross-cultural communication. Second, the "delay and

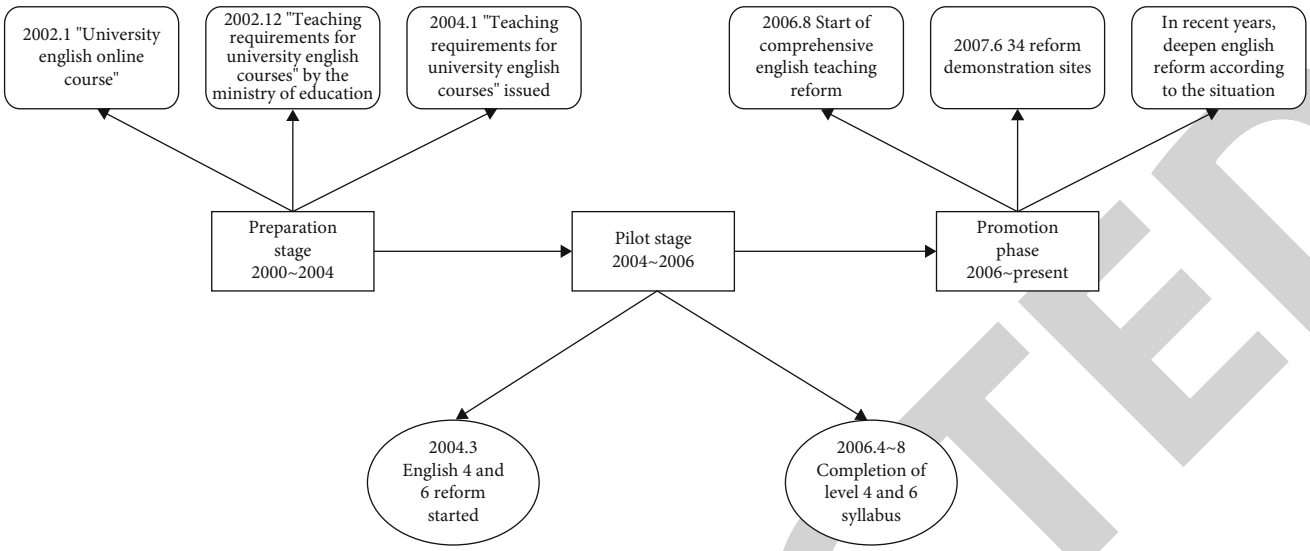

Figure 1: The history of university English teaching reform.

inefficiency" of English language teaching in China's universities is the reason for language development. Although the value of English language teaching is both in higher education and training specialists who account for one-tenth of the total rate, related notes, and time of day by bachelor graduates, college graduates are dissatisfied with the use of the language and, most importantly, their oral communication. Although many students improve their English reading skills by passing university English tests at level 4 or even 6, they often do not have the ability to speak English directly at the international level or in international transactions [20]. University English teaching should be reformed to improve the efficiency of teaching and learning and to facilitate cross-cultural communication for indigenous members with functional English skills. The history of the reform of university English education in China is shown in Figure 1.

3.1.2. Informatization and Educational Development. Informatization of education has been quite an important milestone for the process of education, the reform of education, and the allocation of educational resources. In the context of the world education is going to informatization, the university English education in China should be closely integrated with the Internet technology and network technology and related information technology. Of course there will be some new problems, new challenges, and new opportunities in this integration process, and we should try to overcome these challenges and then meet the new opportunities.

With the continuous development of computer technology, information technology is becoming more and more important and has become more and more prominent in the competition for comprehensive national power. Information technology has promoted the overall progress of countries in all aspects of politics, military, and economy. The United States, the United Kingdom, France, Germany, and other developed countries planned the development path of information technology in the next 50 years as early as the 1990s. In the 1990s, the U.S. government proposed a plan for a national information infrastructure. This was a pioneering achievement in human history. His goal was to develop information technology centered on the Internet, to promote the development of comprehensive information technology in all aspects of society, and to promote the widespread use of information technology in all areas of society. Since then, of course, other countries have subsequently and gradually started the path of informatization. For example, our country clearly put forward the path of informatization development in 1997. Since the establishment of our country's industrial information sector, China's rapid development of information technology. Subsequently, our country also developed a 15-year-long strategy related to the development of national informatization. This side is the first national informatization-related development strategy proposed by China. As countries gradually began to explore informatization, more and more countries joined the war of informatization.

But what exactly is the specific definition of informatization? We look at the definition of informatization and its specific content direction. As for the origin of informatization, it surprisingly originated in the countries of East Asia. In the 1950s and 1960s, Japan first proposed a specific concept about informatization. It was originally proposed by a sociologist from an Asian country in the 1860s. It was later translated into English and spread in the West and then gradually came to our country. In China, General Secretary Xi Jinping should be one of the first to use the term informatization. In an article published in the 1980s about the application of meteorological data information, the first concrete expression of informatization was presented in China. And on the academic side and on the government side of our country, they are discussing the specific concept of informatization in concrete terms. Both the academic side and the government side have a great disagreement about the concept of informatization. Some people think that informatization is a kind of about a process, but some people think that informatization is a process of transformation. Finally, when

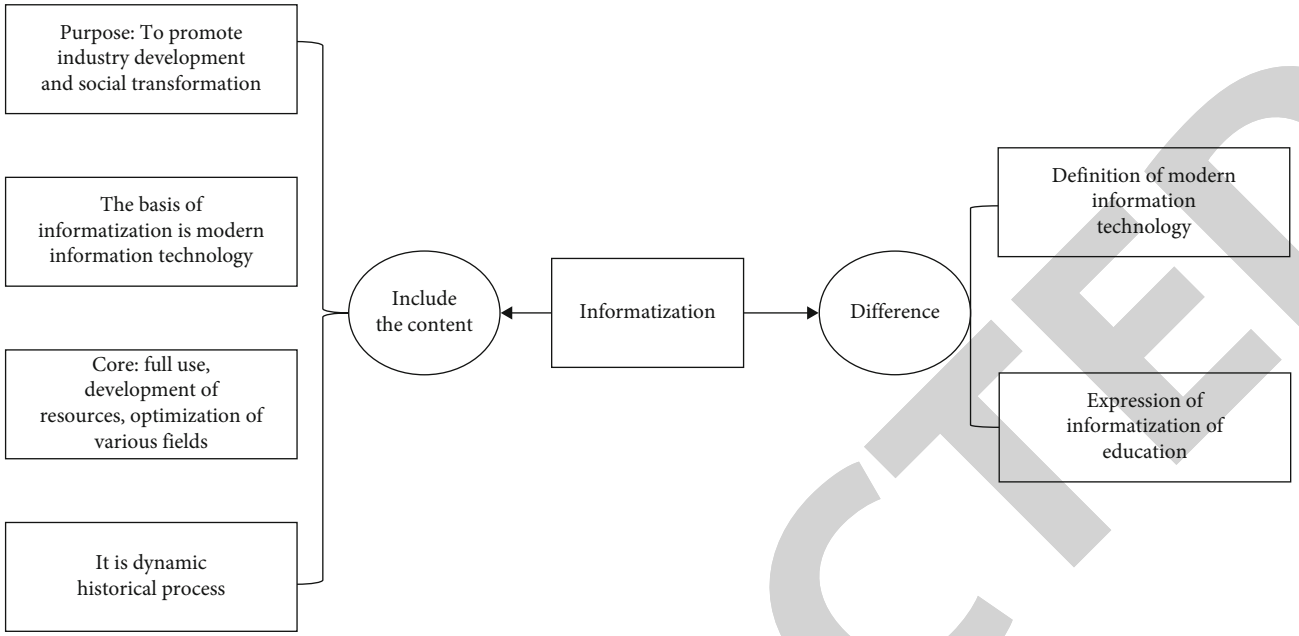

Figure 2: Informatization meaning.

China held its first conference on informatization, China finally made a clear definition of informatization. The definition of informatization was finally determined as long as it can benefit society and then cultivate and develop new productivity-related network tools or intelligent tools, or tools related to the Internet. It is an informatization tool, and then, informatization is this historical process. Before China formulated a 15-year national development plan for the development of information technology, clearly putting forward the purpose of information technology is to promote high-quality economic and social development and promote economic and social transformation. With this purpose, we make full use of information technology, develop information technology, and then fully explore information resources, make full use of information resources, and fully exchange information and share knowledge. Therefore, we make the following judgments on the definition of informatization. First is informatization; it must be to promote social progress, promote social development, and improve people's living standards. Second, informatization is broken to promote the development of various industries and to promote the development of Internet technology. Third, the core part of information technology or to make full use of information technology, on the basis of information technology, it is to promote the development of network technology, to promote social progress, to promote economic development, to promote the progress of industrialization, and to promote the improvement of people's living standards. Of course, the literal understanding of information technology is certainly a long and dynamic process of history. It is a way of development of social civilization. The specific meaning of informatization, as shown in Figure 2.

3.2. Rasch Model Research Method. This model is a model created by a European mathematician who explored continuously in the practice of reflection theory. He started with a specific model of a probabilistic aspect of ability and related problems to increase the difficulty. His aim was still to explore unworthy variables to pursue the answer to the question. For example, he would explore those unrelated systems, the conditions needed within the whole system, and potentially unobservable some of the needed variables. For example, when examining student performance, some aspects of student knowledge and overall student quality and attitude toward learning are examined. Of course, this model is a more idealistic mathematical model, which is modeled with a more processed meaning. It has a better statistical significance, and it has a better fit and has strict requirements for p and u values. [18]. The relationship between the various variables of the model is specified by a mathematical expression that can be expressed mathematically as

$$\log_e \frac{C_{mn}}{1 - C_{mn}} = A_m - B_n, \quad (1)$$

where C_{mn} is the probability of participant m answering question n correctly, A_m is the ability of participant m, and B_n is the difficulty of question n, and in the Rasch model, the corresponding Wyatt chart can be output by inputting the learner's answers. In the graph, the relationship between task difficulty and learning ability is relatively constant through the presentation of the graph, the summary, the learner's knowledge and the probability of answering the question, and the distribution of ability, the rationality of the task setting, and the candidate's ability to adapt can be visualized. If the learner's ability exceeds the task difficulty, the probability is more than half; if they are equal, the probability is greater than half; if the ability is lower than the

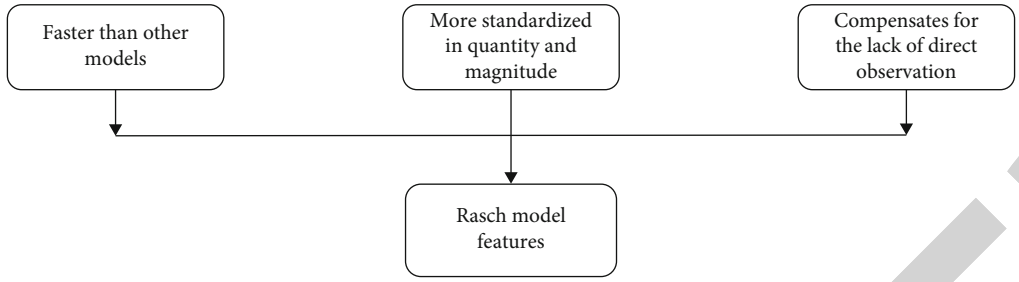

Figure 3: Rasch model analysis characteristics.

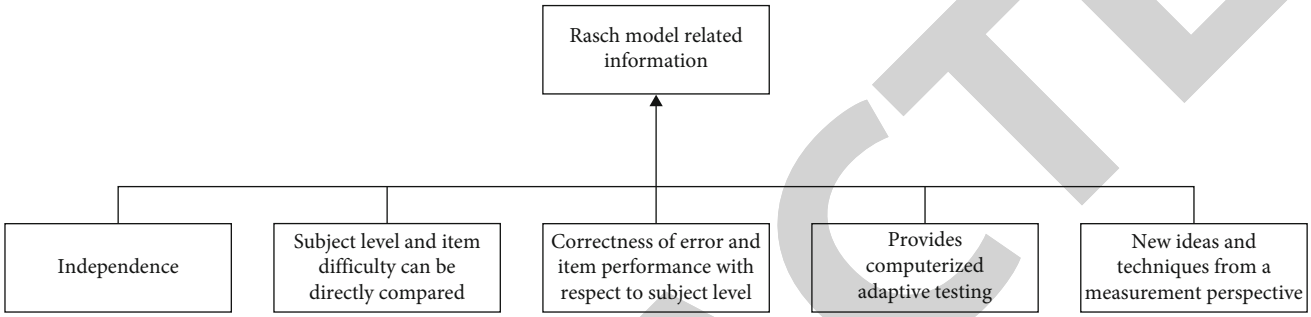

Figure 4: Rasch model-related information.

question difficulty, the probability is greater than half and the probability of answering correctly is less than half. Finally, an appropriate feedback should be provided based on the results of the written report.

As a metric tool based on item evaluation theory, it is different from the general metric theory in nature. First, the question difficulty and student ability are compared on equal scales through logarithmic transformation. The advantage of this approach is that it does not require testing on all questions to predict whether the same student is equally competent, which is the biggest difference between the performance of difficult questions and the performance of general measures, and is more with quick and convenient compared to other models. This is shown in Figure 3.

The Rasch model also has relevant information that is different from other models. (1) First of all, it is independent, which other models do not have. (2) The difficulty associated with certain specific levels in the theory and certain items, which cannot be directly compared. (3) The items tested at the subject's level, the associated errors associated with the subject's level, and the performance of certain equipment. (4) Innovative computerized adaptive testing provides specific schemes and off paths. (5) Presents its own new methodology and its own latest theoretical research from a statistical point of view. The general description, as shown in Figure 4.

4. Results and Discussion

4.1. Study on the Current Situation of English Language Teaching. In this paper, we surveyed three universities in a city in central China, and after comprehensive analysis, we came up with the classroom teaching methods of university English teachers. And the English language teaching methods are studied. First, the survey shows that teachers often use the following teaching methods in class: lecture method, sentence practice method, situational dialogue method, rapid response method, and teacher-directed classroom discussion method. Their mean values were 4.07, 2.11, 2.03, 1.91, and 2.98, respectively (counted by the number of times the teachers chose). This is shown in Figure 5.

In contrast, the learner-centered reflective writing method, journal dialogue method, field trip method, student-led discussion method, and problem-centered method were not frequently used by teachers in the classroom, and their mean values were 1.04, 0.30, 0.40, 1.23, and 1.37 (counted by the number of times teachers chose them). There is a large discrepancy with students' expectations of teaching methods, as shown in Figure 6.

According to this survey, it was found that in the university English teaching reform, English teachers tried several new university English teaching models, but most of them adopted the traditional teacher-centered classroom teaching methods. For example, the "problem-driven approach" (abbreviation of PBL model: PBL places learning in a complex and meaningful environment and then solves problems through students' cooperative learning to master language skills), but most teachers think the PBL model is difficult: it is not suitable for students with poor English foundation in order to control the curriculum. Teachers also have some difficulties in evaluating learning outcomes. As a result, they are still accustomed to completely controlling students' classroom learning rather than giving them more opportunities to understand. As a result, the current educational reform is out of touch with teachers' teaching methods.

Currently, college teachers generally consider PPT as an intuitive method of classroom teaching, and some colleges and universities have proposed PPT as an evaluation

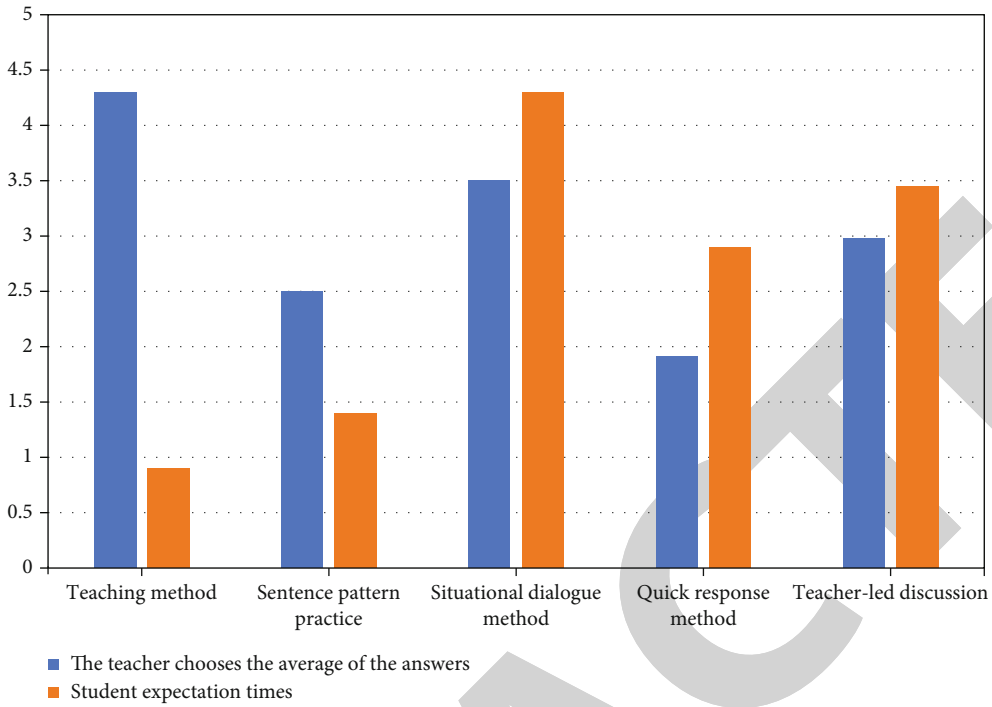

Figure 5: Survey of teachers' common teaching methods.

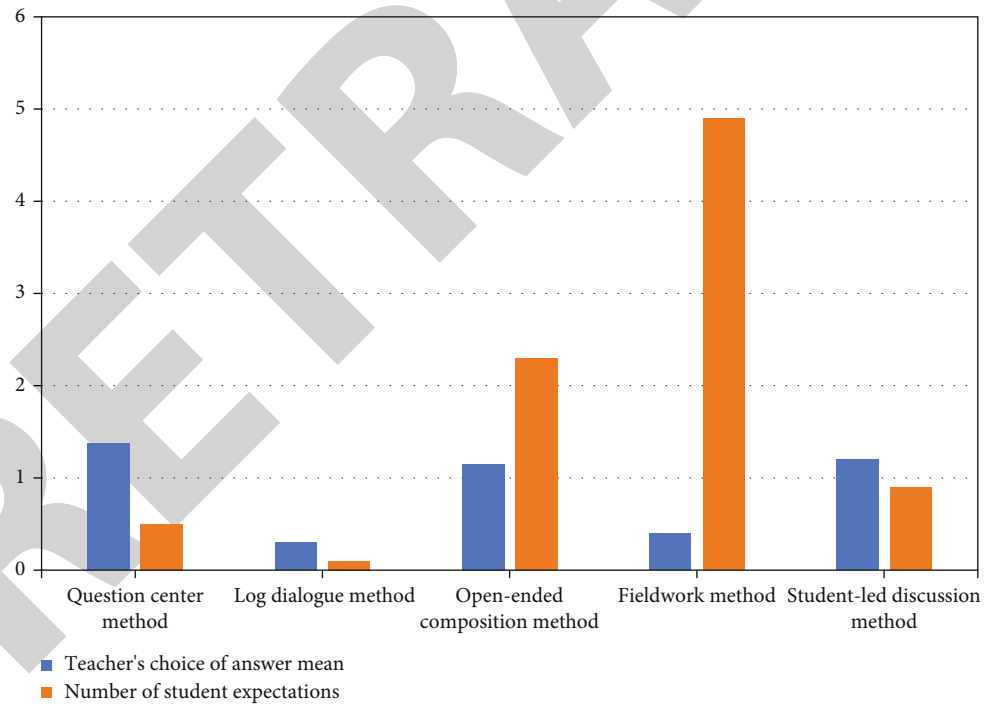

Figure 6: Learner-centered teaching methods survey.

criterion for classroom teaching. In order to better understand the classroom situation of GADA English teachers and promote the application of PPT in college English teaching, the authors conducted a PPT questionnaire survey and classroom observation of GADA English teachers.

In response to the question of how to choose the teaching mode, 100% of the teachers said they often use text and PPT to present class content and useful information to students; 92.6% said they often focus on writing-related issues; 72.3% explained that they often insert pictures in PPT; 20.6% said they sometimes add animations, videos, and audio links. 81.8% of teachers indicated that they look for resources on the Internet and then develop textbooks within textbooks. In subsequent interviews, the authors

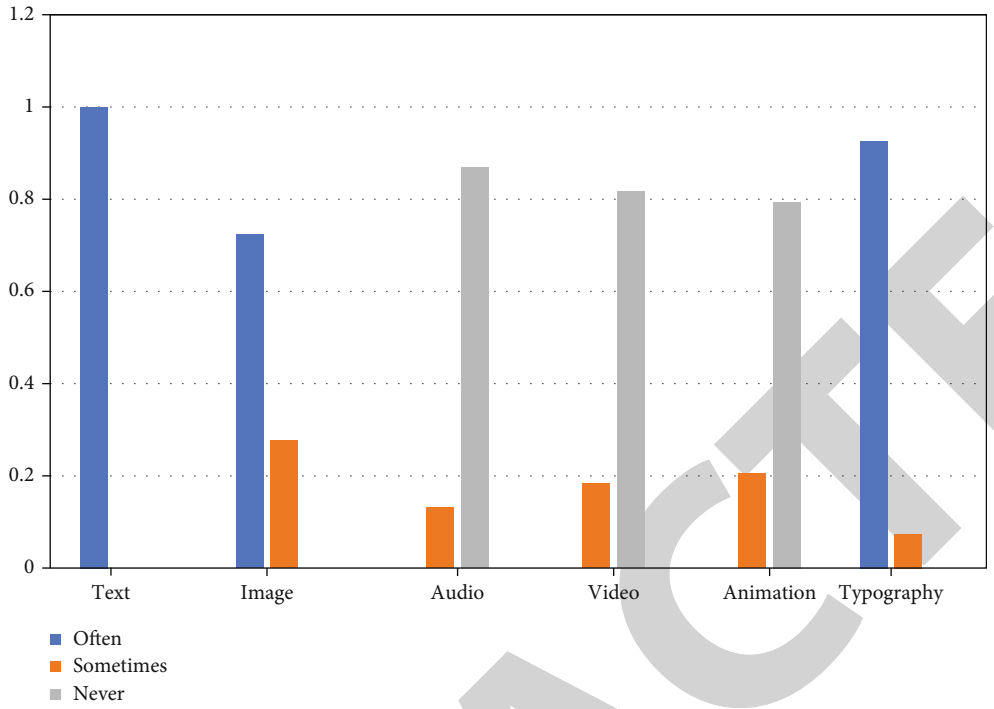

Figure 7: Statistics of instructional modalities used by teachers in creating multimedia courseware.

noted that the vast majority of college English textbooks are provided by publishers. They are placed in the classroom without any changes, but their content is selectively presented due to the limited time available for the course, as shown in Figure 7.

The researchers of this study conducted a uniform statistic of that usage of teachers using PPT courseware. There were more than 90% of teachers who mostly prefer to use PPT for teaching. There is a tendency to rely on PPT for teaching. This paper further explores some of the methods and difficulties encountered with PPT as well as the methods used in dealing with the process. It is found that the classroom relies on PPT more seriously and the teachers' methods of handling the situation are not appropriate enough if they encounter unexpected situations. The specific performance is shown in the figure. According to this this, statistics found that PPT accounts for a very, very large role in the teaching process, but the reliance on PPT in colleges and universities is too high.

In the survey of colleges and universities, this paper makes reference to 225 colleges and universities for English teaching again. In the context of information reform, the widespread use of teaching networks and the lack of sufficient interaction between teachers and students in some teaching systems have made synchronous communication delayed and difficult, and the communication intensity between teachers and students is low. This includes information communication and emotional communication. However, there are extensive cognitive and affective barriers to online learning. The goals of e-learning are described as "student-centered" and "student-directed." The goal of education is to develop highly intelligent people and to explore how to transfer knowledge and skills to students, while the type of emotional communication is neglected. Online learning is important for emotional education, but it is not essential. Some teachers have limited or nonexistent access to online learning for their students and never answer their students' online learning questions or ask them about their online learning. This makes students feel isolated in their learning. In addition, some teachers' misconceptions about online teaching and learning lead to a significant decrease in student-teacher interaction. This reduction in communication and interaction not only affects students' academic performance but also leads to areas of dissonance.

Teachers must take 10 or more courses in the course of teaching, which also means that each teacher must take multiple courses at the same time and hundreds of students must understand and master them. This is not conducive to maintaining a closer and harmonious relationship between teachers and students. In terms of teachers and students, the professional status of the classroom is obviously unbalanced. One reason is that the traditional form of classroom teaching still exists. When a topic is in the classroom, the teacher dominates the classroom, and the students are passively followed. The second reason is the long-term impact of traditional Chinese education that keeps students silent and listened to class. I am used to a quiet exam. Even if the teacher organizes interactive activities in the classroom, it is often not only to stimulate the enthusiasm of students but also for the brain. This authoritative and obedient relationship is difficult to transform into a more balanced and harmonious teacher-student relationship. In such a turbulent environment, it is more difficult for teachers and students to grow together. We often say that students are trained by teachers, and teachers are trained by students. This is the so-called "harmony." In environmental

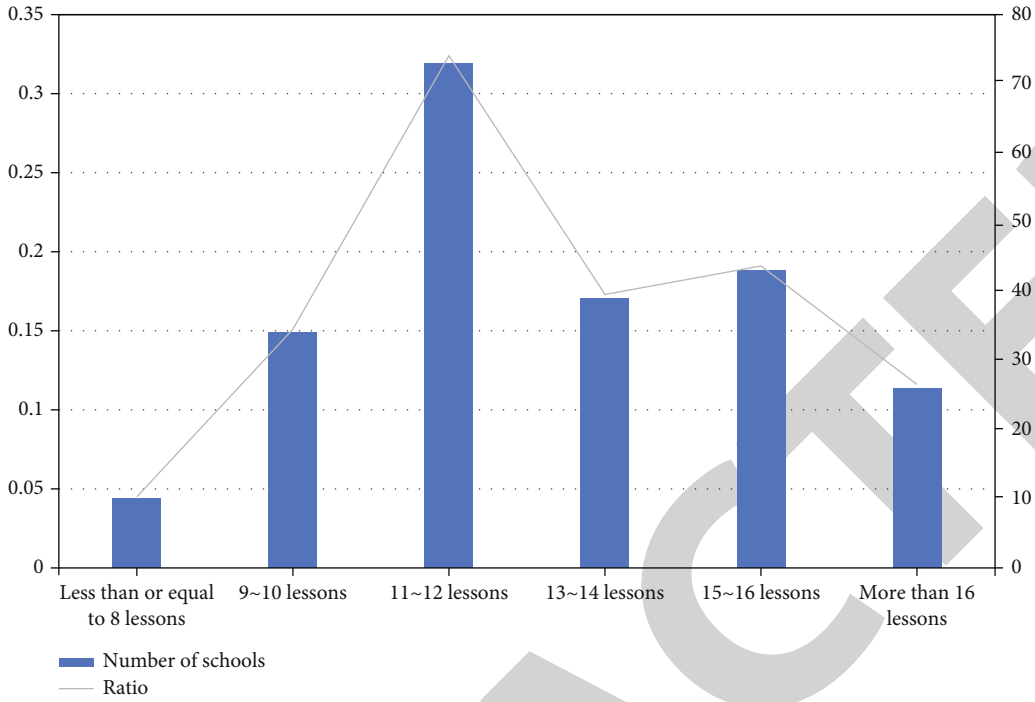

Figure 8: The actual weekly class of English teachers in universities.

classrooms, teaching work serves the growth of students. Teachers get nutrition during the learning process and increase professional development opportunities. This teacher-student circle represents a good classroom ecosystem, and teachers can develop better and provide students with better teaching services. However, in the process of information development, teachers' vocational education has not received enough attention in teaching management. It is difficult to synchronize the development of the widespread application of modern information technology to achieve joint teaching of teachers and students, as shown in Figure 8.

4.2. Suggestions for English Language Teaching Development

4.2.1. Educators Should Hold Objective Information Teaching Awareness and Positioning Standards. As a new method of information teaching, information teaching should take the promotion and optimization of the information process as one of the development tasks in the implementation process, adhere to the student centric teaching activities and attitudes, while reducing students' enthusiasm and initiative. We must also use the opportunities of dialogue, cooperation and exchanges to cultivate students' subjective initiative and accurately determine computer teaching standards. Old and old teaching methods based on modern technology must be abandoned, rather than traditional teaching methods such as mechanical reeducation and refining. Therefore, maintaining objective and comprehensive information teaching awareness and attitude is the prerequisite and ideological guarantee for the success of scientific research.

Adhere to the target positioning standards of informatization, take student development as the task of development and optimization of information services, combine teaching practice with the awareness and sensitivity of informatization goals, and effectively use teaching resources. Designing more targeted and initiative English learning models stimulate students' learning interest and curiosity. Interest is the first teacher. It is an emotional state caused by external motivation, and it is also the motivation and necessary condition that stimulates students' learning and creativity.

Starting from the objective standards of informatization and informatization direction, the teachers can truly strive to achieve specific goals. In order to avoid misunderstanding of your information technology knowledge and standards, you cannot make full use of information resources to optimize teaching services, such as using network resources and English courses to teach multimedia resources to provide students with extensive browsing and downloading information; in information-based English learning, in the process, teachers can also choose the appropriate textbooks to write related textbooks so that students can learn through the electronic network platform, broaden their learning horizons, and enrich knowledge and energy. In addition, teachers should use advanced teaching facilities and facilities more widely, such as multifunctional classrooms and language laboratories, and using the network resources they provided to make students truly feel language, such as character simulation and scenario dialogue. Students can feel the language skills needed for future work, so that they can learn more specific.

4.2.2. Design High-Quality Information English Teaching Mode to Promote the Implementation of Teaching. The main problems encountered by teachers in information applications and the lack of understanding of information on

informationization issues are related to the concept of informatization. They lack information technology and skills, partly because the advantages and characteristics of information learning are not adapted to the nature and purpose of learning, and they need to lay the foundation for the implementation of information learning. Establish information teaching models suitable for teaching tasks and disciplines and introduce them into teaching practice. Explore information diversity platforms, enrich high-quality textbooks, and expand information knowledge bases. The organization and design of computer-assisted teaching depends on the breadth, speed of teaching content, and the close relationship between teaching and information. Teachers should examine information based on the goals and types of the curriculum, instead of copying all information without considering priority and difficulties, so that the information loses its original purpose and significance. Teachers must also measure the progress according to the knowledge and recognition of the discipline to seek perfection. The development of high-quality information and English teaching form can solve related problems in my country and promote the effective implementation of teaching.

In the reform of high-level English teaching, educators and relevant education departments should improve information literacy and practical ability, improve teaching concepts, and make full use of modern information technology and network resources in teaching practice. Establish a high-quality English teaching information model. This requires English teachers to master the basic skills and knowledge of modern computers. In order to promote the reform of university English teaching, teachers must learn to use information technology in English teaching. Not only do they have to perform surface operations on multimedia but they also pay attention to in-depth research and understanding of the characteristics and advantages of the information age. Under the conditions of information technology, you should adjust your teaching methods, combine the teaching contents and practical requirements, and establish a high-quality teaching model. Update your educational concepts and behaviors. When designing a high-quality information model, relevant principles and points should also be considered in order to improve the teaching effect of information space.

4.2.3. Promote the Development of Information Teaching Resources on the Basis of Combined Teaching Practice. On the basis of understanding the objective standards and directions of information teaching, construct high-quality English information teaching models to facilitate teaching implementation and further promote the development of teaching skills in combination with teaching practice. Give full play to the advantages of information technology teaching and learning for teaching and learning.

In promoting the development of teaching materials, the nature and content of teaching materials can be diversified and comprehensive, and the advantages of telemedicine can be fully utilized to increase students' learning opportunities in specific environments. Internet resources provide our teachers and students with a wide variety of information that enables us to understand financial, business, cultural, scientific, and humanistic habits, broaden our horizons and knowledge, and better invest in specific projects. According to the teaching requirements, when creating a learning environment, materials should be designed to be of interest to students and to have an effect in the classroom, according to their attention and relevant aspects of their daily life or learning. The teaching message should extend from teacher-student communication to multifaceted and multimodal interaction, combining language and life experiences to propose different forms of teaching and activating the material. Students are enabled to flexibly integrate what they learn with the intelligent points in their surroundings.

5. Conclusion

With the continuous development of science, technology, and productivity in society, the application of modern information technology such as computers and multimedia networks is becoming more and more popular, promoting the emergence of information-based teaching methods and teaching means in the field of education. Under the condition that the level of teaching technology is improving and the application of computers is becoming more and more widespread, the emergence and high-level utilization of teaching methods under the conditions of informatization show a trend of innovation. According to the trends and tendencies of the educational era, reasonable and flexible use of multimedia networks and information teaching in computers to support educational reform will help to improve teaching effectiveness and promote the spirit of modern education. In the process of teaching college English, teachers should make more use of information technology and modern teaching methods and techniques to introduce and express teaching contents and teaching concepts more comprehensively and to reflect modern educational ideas based on language use. In order to improve the quality and efficiency of college English teaching, it should be more student-centered. The continuous changes in the information age have gradually given rise to the information-based education model, which is a teaching model and a new learning method based on the continuous development of computer technology and the innovation of information technology. With the basic conditions of modern information technology, information-based teaching exists in the design concept and related teaching practice. The effective use of modern information technology and Internet big data processing technology to realize the effective integration of English teaching in colleges and universities with contemporary information technology is a key project in the current construction of higher education institutions in China. This paper analyzes the main features in English teaching in colleges and universities in the left and presents the outlook of information-based English teaching according to the current needs of Internet teaching. This paper focuses on the principles, theoretical basis, current situation, and effectiveness of integration of English teaching in higher education institutions under the information technology environment. The perspective of this paper begins with the practices related to informational teaching, further investigates the important

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Research Article

Research on Image Classification and Key Technologies Based on 3D Feature Extraction Algorithm

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Image classification and recognition has a very wide range of applications in computer vision, which involves many fields, such as image retrieval, image analysis, and robot positioning. Especially with the rise of brain science and cognitive science research, as well as the increasing diversification of imaging means, three-dimensional image data mainly based on magnetic resonance image plays an increasingly important role in image classification and recognition, especially in medical image classification and recognition. However, due to the high dimensional characteristics of human magnetic resonance images, human readability is reduced. Therefore, classification and recognition of 3-dimensional images is still a challenge. In order to better extract local features from images and effectively use their spatial information, this paper improved the "feature bag" and "spatial pyramid matching" algorithms on the basis of 3D feature extraction algorithm and proposed an image classification framework based on 3D feature extraction algorithm. Firstly, the multiresolution "3D spatial pyramid" algorithm, the multiscale image segmentation and image representation method, and the SVM classifier and feature fusion method are described. Secondly, the gender information contained in the magnetic resonance images is classified and recognized on the three databases selected in the experiment. Experimental results show that this method can effectively utilize the spatial information of three-dimensional images and achieve satisfactory results in the classification and recognition of human magnetic resonance images.

1. Introduction

Biological visual systems have the ability to automatically recognize and recognize objects and can adapt to particularly complex environments, which are still far from being compared with existing computer systems [1]. The biological visual system has the ability to perceive the changes of illumination, scale, position, and rotation of the target unchanged and the ability to automatically group the ordered visual features [2].

With the development of brain science and cognitive science, more and more three-dimensional images, such as magnetic resonance images, are used in medical clinical diagnosis and the study of human brain cognitive function. Compared with the traditional two-dimensional images, people's ability of identification and discrimination will be significantly reduced, and the information contained in three-dimensional images cannot be effectively identified, which has gradually become a key issue in computer vision and cognitive science [3, 4].

It is precisely because of many problems in the field of computer vision. The difficulty of target recognition, scene classification, and human brain pattern analysis is significantly increased. To improve the accuracy of target recognition, the accuracy of scene classification, and the reliability of diagnosis of mental diseases related to human brain, the key lies in how to effectively overcome the changes of illumination, deformation, translation, rotation, occlusion, and noise and extract features from images [5]. How to express the image more effectively by improving the algorithm and how to express the information in the image more effectively by improving the feature description is particularly important for the field of computer vision and cognitive science [6].

In order to better extract local features of images and effectively utilize their spatial information, this paper improves the algorithms of "feature bag" and "spatial pyramid matching"

on the basis of three-dimensional feature extraction algorithm, and proposes an image classification framework based on three-dimensional feature extraction algorithm [7, 8]. Experiments show that this method can effectively use the spatial information of three-dimensional images and has achieved ideal results in the classification and recognition of human brain magnetic resonance images [9].

In order to extract image local features better and use their spatial information effectively, this paper proposes an image classification framework based on three-dimensional feature extraction algorithm, which improves the "bag of features" and "spatial pyramid matching" algorithm effectively. Experiments show that this method can effectively use the spatial information of 3D images and has achieved ideal results in the classification and recognition of human brain magnetic resonance images. The method proposed in this paper can effectively process the magnetic resonance image, and the recognition effect is ideal. In the relevant tests, the recognition effect of image processing is better, and it has important application prospects in the medical image processing of the hospital.

2. Brief Introduction of "Feature Bag" Method and "Spatial Pyramid Matching" Algorithm

In recent years, the "bag-of-words" model has achieved great success in the application of document analysis and information retrieval [10]. Inspired by this, many scholars creatively applied this model to image classification and recognition and called this method "bag-of-features" model. Because the "feature bag" model can combine various interest point detection methods and local image region description methods, it is very effective in representing images, so it also obtains very good recognition results [11]. Therefore, this method has naturally become the mainstream algorithm of image classification and recognition so far.

Although the idea of this "feature bag" model is very simple, it has obtained better recognition results. Lzaebnik and others improved the traditional "feature bag" method and proposed the "spatial pyramid matching" (SPM) algorithm. This algorithm, abbreviated as SPM, divides the image from coarse to fine, divided into many subregions, gets the feature histogram of each subregion, and uses support vector machine (SVM) to carry out the final classification and recognition, so as to get a better recognition result compared with the "feature bag" method, so this method has also been widely concerned and applied. Up to now, there are many methods in the field of image classification and recognition that use SPM algorithm for reference.

2.1. "Feature Bag" Method. Generally speaking, this image modeling method based on the "feature bag" model includes the following four steps: The first step is feature detection and description, the second step is to build a visual word bank, the third step is to build an image description vector, and the last step is classifier training (as shown in Figure 1). Next, these four steps are introduced in detail.

2.1.1. Feature Detection and Description. For each image in the image set, the feature detection and description become the first main step of the "feature bag" method. The method of extracting the local invariant features of the image which we introduced before will become a powerful tool to characterize the image. In the early days, images based on the "bag of features" were applied to classification and recognition methods. In the process of image feature detection, usually, various feature detection methods which satisfy affine invariance, scale invariance, and rotation invariance are adopted. Then, some recent studies also show that dense sampling method can improve the performance of image classification and recognition algorithm more effectively than corner detection method speckle detection method and region detection method and other local invariant feature detection methods [12–14]. For feature description, there are many methods, the most famous of which is SIFT descriptor, because its performance is very good, so it has a very wide range of applications in image classification and recognition [15].

2.1.2. Creating a Visual Vocabulary. Visual word library is usually created by clustering the local invariant features extracted from the images in the training set. Each clustering center corresponds to the words in a visual dictionary and all the visual words form a visual dictionary (sometimes called codebook). So far, the simplest clustering method is to cluster according to the mean square error. The basic idea of clustering method based on mean square error is to minimize the distance within the cluster and maximize the distance between the clusters. The most commonly used method to construct visual word library is k-means clustering.

2.1.3. Constructing Image Description Vectors. Then, after the visual word library is established, the method similar to the vector space model (VSM) in text retrieval is adopted to represent each image as a vector. So specifically, That is, the local features from each image are described by mapping, Corresponding to the codebook in the visual dictionary, then according to the mapping of features on the codebook, the frequency of local features appearing in the visual dictionary is counted, and then the image is expressed as a vector by using the statistical information.

2.1.4. Classifier Training. At this time, the description vector of the image used for training is used as the training sample to train the classifier. Then, whenever there is an image to be recognized, the image to be recognized is represented by visual word bank, which is expressed in vector form and then sent to the trained classifier, thus completing the task of image recognition and classification. Up to now, the most commonly used classifiers are nearest neighbor classifier, Bayes classifier, and SVM.

2.2. "Spatial Pyramid Matching" Algorithm. Although the idea of "feature bag" method is simple and the result is better, all spatial information is ignored in the construction process. Therefore, to a certain extent, some useful information is lost, which limits its descriptive ability to some extent.

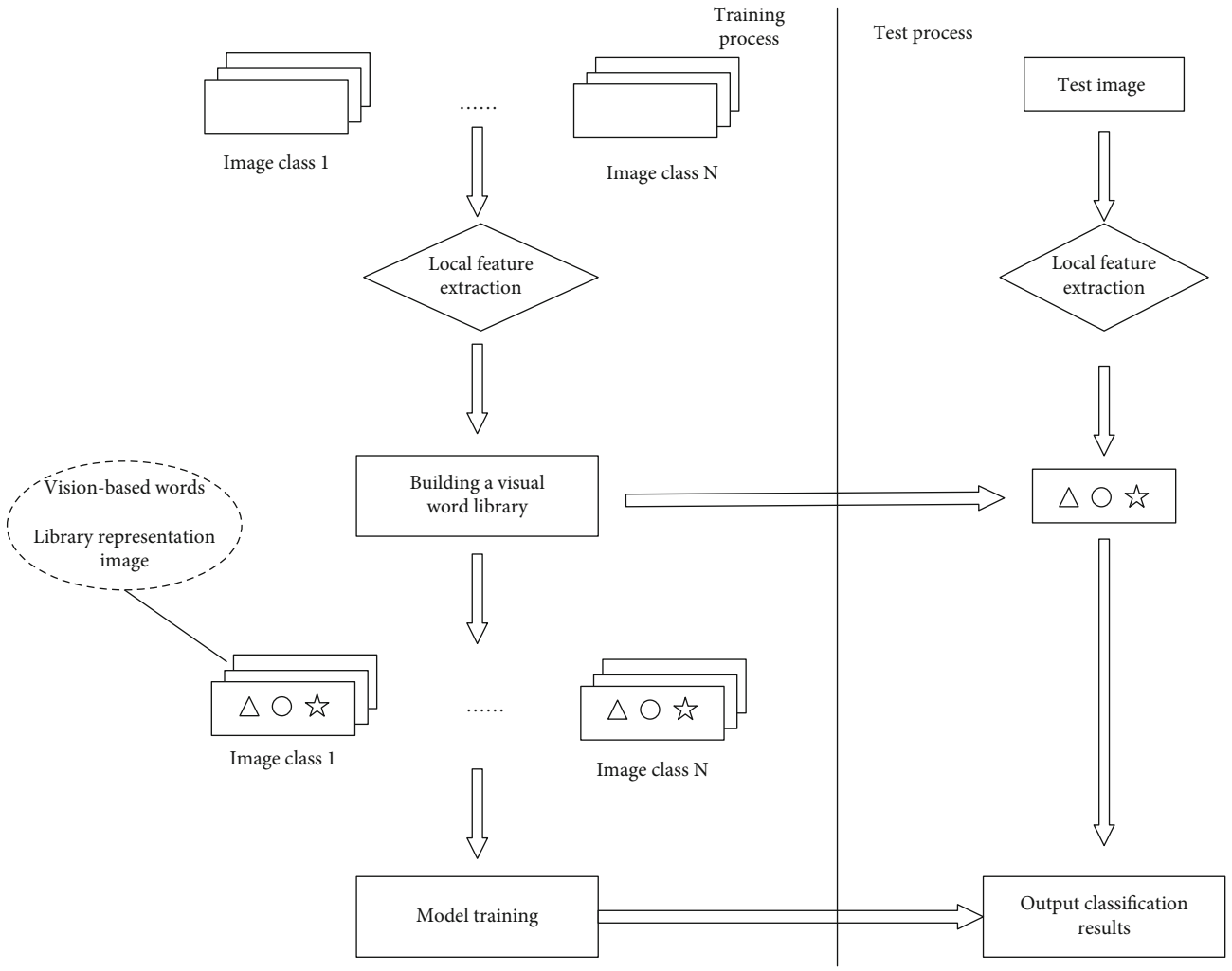

Figure 1: Flow chart of "feature bag" method.

Then, a man named Lazebnik improved this algorithm to a certain extent and, on this basis, proposed an algorithm called "spatial pyramid matching."

This so-called spatial pyramid matching algorithm is another image classification framework derived from the "feature bag" algorithm. It brings the concept of "multiscale" and makes use of more spatial position information on the basis of the "feature bag" method, thus improving the performance of recognition and classification to a great extent. As shown in Figure 2, we can see that this method uses different scales, subdivides the image from coarse to subdivided into many subregions, and calculates their local features and their "feature bag" expression on each subregion.

Figure 3 is a flow chart of "spatial pyramid matching" algorithm, Compared with the "feature bag" method, the improvement of this method is that when the image is represented by the "feature bag" method, in this method, the image is divided from coarse to fine, and the spatial position relationship between features is preserved. The image is divided into more fine subregions by three pyramid scales, and local features and their "feature bag" representation are calculated on the subregions divided by each scale. Then, according to a certain weight, the "feature bag" expression of subregions in each scale is connected to form a spatial pyramid vector. Finally, each image is expressed by the spatial pyramid vector, and then the classifier is trained and tested. The expression of "spatial pyramid matching" framework is very concise, and the computational efficiency is particularly high, so many methods have adopted this framework so far.

2.3. Support Vector Machines. Support vector machine (SVM) was proposed in the late 1990s. It is a newer and more general machine learning algorithm under the framework of "statistical learning theory". This theory creates the hyperplane of optimal classification in the original feature space by using the optimization principle. Because most classification problems belong to nonlinear classification problems, support vector machines under the main linear indivisible conditions are more widely used. Next, the working principle of SVM under the condition of linear indivisibility is briefly introduced.

Generally speaking, when the linearity can be distinguished, the classification interface obtained by SVM can not only distinguish the two types of samples correctly, but

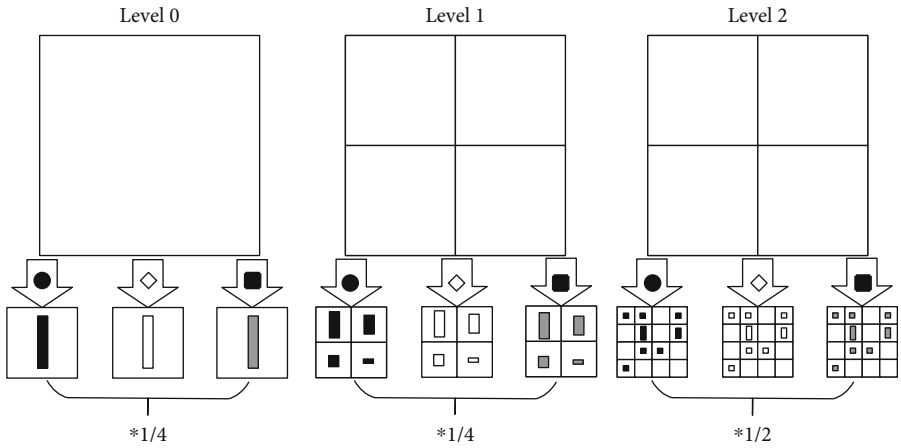

Figure 2: Schematic diagram of "spatial pyramid matching" algorithm.

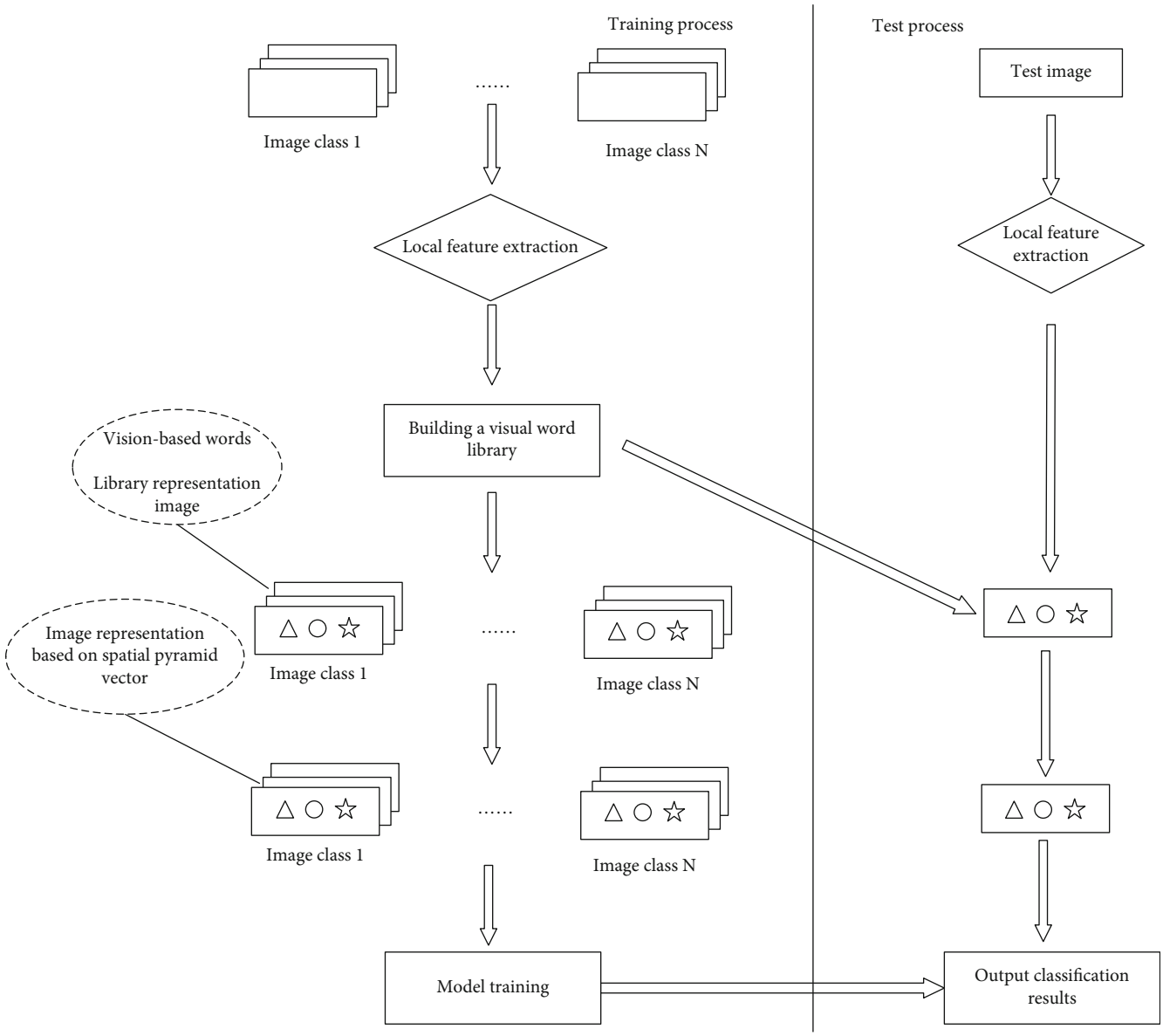

Figure 3: Flow chart of "spatial pyramid matching" algorithm.

also ensure that the distance between the classification interface and the support vector (the closest sample point) is the largest, so the obtained classification surface should be the optimal classification surface. If it is linearly indistinguishable, there will be no optimal classification surface described above, and researchers call the classification surface obtained in this case generalized optimal classification hyperplane.

For example, the dimension of the training sample is D, which is denoted as $x_1, x_2, \cdots, x_N$. Class A samples are $x_k(k = 1, 2, \cdots, N_1)$, the corresponding category label is $y_k = 1$, Class B samples are $x_j(j = 1, 2, \cdots, N_2)$, and the corresponding category label is $y_j = -1$, so we can easily get $N = N_1 + N_2$, so for the training sample set $\{x_i\}$, they can be expressed as $\{x_i, y_i\}$. If the training samples are linearly indivisible, there will be a problem of determining the generalized optimal classification hyperplane.

The general form of the D-dimensional linear discriminant function in the feature space should be

$$d(x) = w_d^T x + b. \tag{1}$$

Therefore, under the condition that linearity can be distinguished, the symbolic normalization operation is carried out for the two types of samples of Class A and Class B, so we can get

$$y_i\left(w_d^T x + b\right) \geq 1 (i = 1, 2, \cdots, N). \tag{2}$$

Then, in the case of indistinguishable linearity, the requirements of Equation (2) cannot be met between these two types of samples. At the same time, in order to overcome the influence of noise points or even outliers, and to take into account more sample points to a certain extent, we usually adopt the method called soft interval, in which the commonly used methods are called simplified generalized optimal classification surface and interval interface.

In the constraint condition:

$$y_i\left(w_d^T x + b\right) \geq 1 - \xi_i, i = 1, 2, \cdots, N. \tag{3}$$

Under the condition that holds, the following objective functions are minimized:

$$f(w, \xi) = \frac{1}{2} w_d^T w_d + C \sum_{i=1}^{N} \xi_i. \tag{4}$$

In Formula (4), N represents the number of training samples, and C represents a normal constant (then under normal circumstances, this parameter is artificially specified). The larger the value of this value, to some extent, the greater the penalty for outliers, and the narrower the interval between the corresponding classification planes. Therefore, the problems described above can naturally be translated into the following planning problems:

$$\begin{aligned} \min \quad & \frac{1}{2} w_d^T w_d + C \sum_{i=1}^{N} \xi_i \\ \text{s.t.} \quad & y_i\left(w_d^T x_i + b\right) - 1 + \xi_i \geq 0 \; i = 1, 2, \cdots, N \\ & \xi_i \geq 0 \end{aligned} \tag{5}$$

Make a Lagrangian function:

$$\begin{aligned} L(w_d, b, \xi, \lambda, \beta) = {} & \frac{1}{2} w_d^T w_d + C \sum_{i=1}^{N} \xi_i - \sum_{i=1}^{N} \lambda_i \\ & \cdot \left[y_i\left(w_d^T x_i + b\right) - 1 + \xi_i\right] - \sum_{i=1}^{N} \beta_i \xi_i. \end{aligned} \tag{6}$$

By using K-K-T theorem and extreme value condition, w_d, b, ξ has

$$w_d = \sum_{i=1}^{N} \lambda_i y_i x_i. \tag{7}$$

From the nonnegative conditions $\beta_i \geq 0$ and $C - \lambda_i - \beta_i = 0$, we can easily get $C \geq \lambda_i \geq 0, i = 1, 2, \cdots, N$.

This equation shows that C controls the range of λ_i, that is to say, it controls the effect of noise and the influence of outliers on the result. The complementary relaxation condition of this minimization problem is the following equation:

$$\begin{cases} \lambda_i\left[y_i\left(w^T x_i + b\right) - 1 + \xi_i\right] = 0 \\ \beta_i \xi_i = (C - \lambda_i)\xi_i = 0 \end{cases}. \tag{8}$$

The patterns with $\lambda_i > 0$ are called support vectors, and they are the so-called patterns that lie in, between, and outside the two standard hyperplanes, but can be misclassified. According to the complementary relaxation conditions mentioned above, we can see that if a pattern satisfies $C > \lambda_i > 0$, then there must be $\xi_i = 0$, and the distance between them and the classification plane should be $1/\|w\|$. Then, when $1/\|w\|$, it is possible to be nonzero after relaxing variables; if this $C = \lambda_i$, it means that the pattern is correctly classified, but the distance from it to the classification plane is less than $1/\|w\|$. If $\xi_i < 1$, this pattern will be misclassified, so it is located between or outside these two standard hyperplanes. In this case, the dual problem of the programming problem mentioned above is in the following form:

$$\begin{aligned} \max \quad & \sum_{i=1}^{N} \lambda_i - \frac{1}{2} \sum_{i=1}^{N} \sum_{j=1}^{N} \lambda_i \lambda_j y_i y_j x_i^T x_j \\ s.t. \quad & \sum_{i=1}^{N} \lambda_i y_i = 0 \\ & 0 \leq \lambda_i \leq C \end{aligned} \tag{9}$$

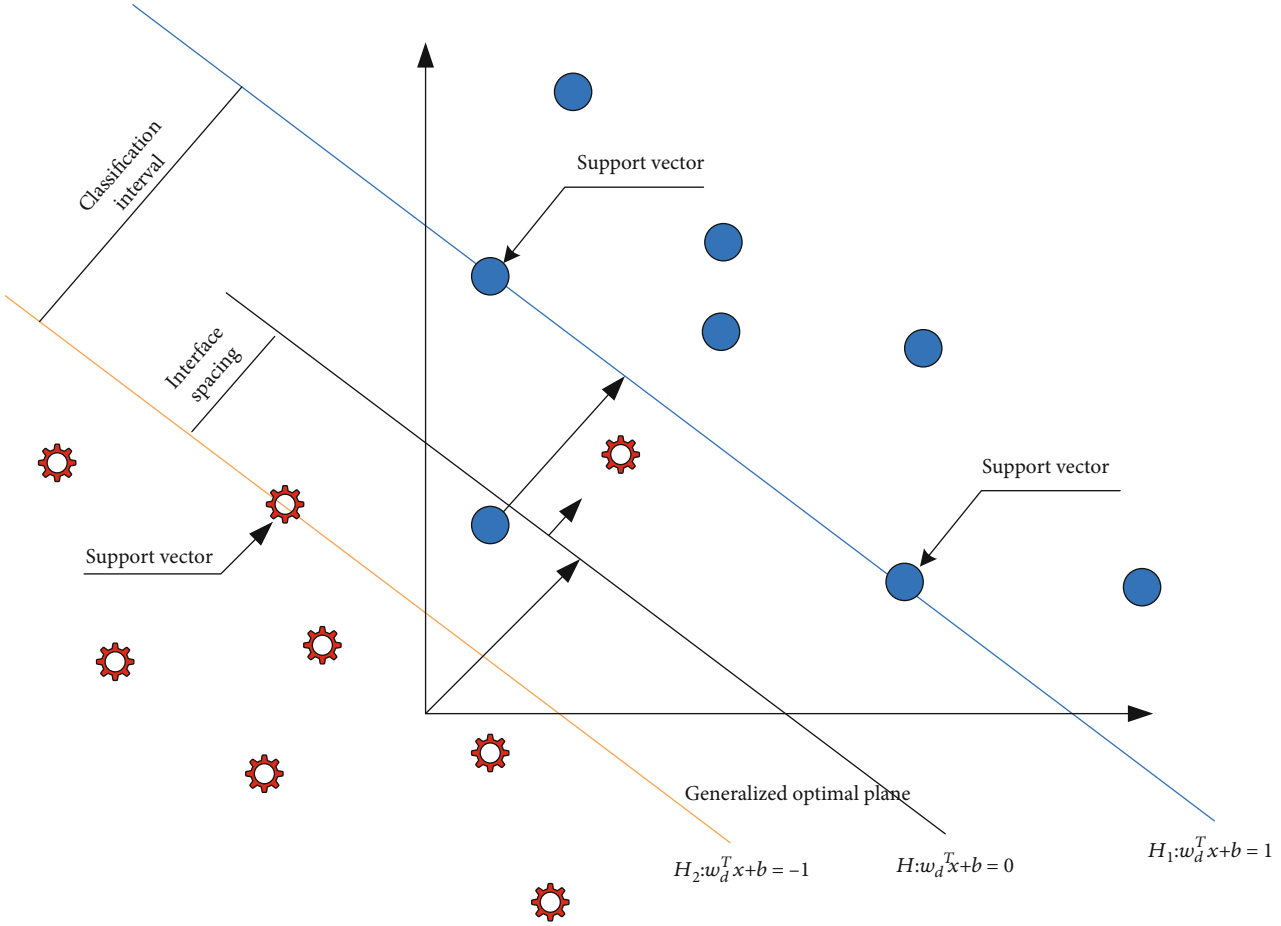

Figure 4: Generalized optimal classification surface in the case of two-dimensional linear indivisibility.

$\lambda_i^*(i=1,2,\cdots,N)$ is obtained from the above programming solution, and a simplified generalized optimal classification surface equation can be obtained as follows:

$$d(x)=\sum_{i=1}^{N}\lambda_i^* y_i x_i^T x+b*=0. \tag{10}$$

It is necessary to choose the value of $b*$ so that its value meets the establishment of $y_j d(x_j)=1$. In this case, the parameter C can be adjusted in a certain range until the optimal classification surface is obtained. Figure 4 shows an example of such a generalized classification surface in the case of linear indistinguishability in two dimensions. From this graph, we can see that there will inevitably be misclassified samples on both sides of the generalized optimal classification surface.

3. "Multiresolution 3D pyramid" Algorithm

This section improves the "feature bag" method and the aforementioned "spatial pyramid matching" algorithm. The effect is very good, the purpose is to make better use of three-dimensional features and the spatial relationship between three-dimensional features, and on this basis, a "multi-resolution three-dimensional spatial pyramid" algorithm is proposed to make it more suitable for the classification and recognition of three-dimensional images.

3.1. Overview. In the framework of "multi-resolution three-dimensional pyramid" algorithm, it mainly includes two parts, namely, training and testing. In the training process, we first perform subsampling processing on the training images and use this method to create three images with different resolutions. Then, after getting these three images with different resolutions, firstly, using dense sampling method and using the three-dimensional feature extraction algorithm proposed in the previous chapter, three-dimensional local feature extraction is carried out for images with all resolutions. Then, we use the simplest k-means clustering algorithm to create a visual dictionary, and map the three-dimensional features; we extracted before to the corresponding codebook of the visual dictionary. At the same time, all images with three resolutions are spatially divided in three directions, when dividing spatial areas. Because the resolution of images is different, so we use different scales. In this way, after three-dimensional space division, a three-dimensional spatial pyramid is formed, and then each spatial subregion is represented by a method similar to the "feature bag" method, and then the image descriptions of all spatial subregions at this resolution are connected as the image description vectors at this resolution. Then, after obtaining

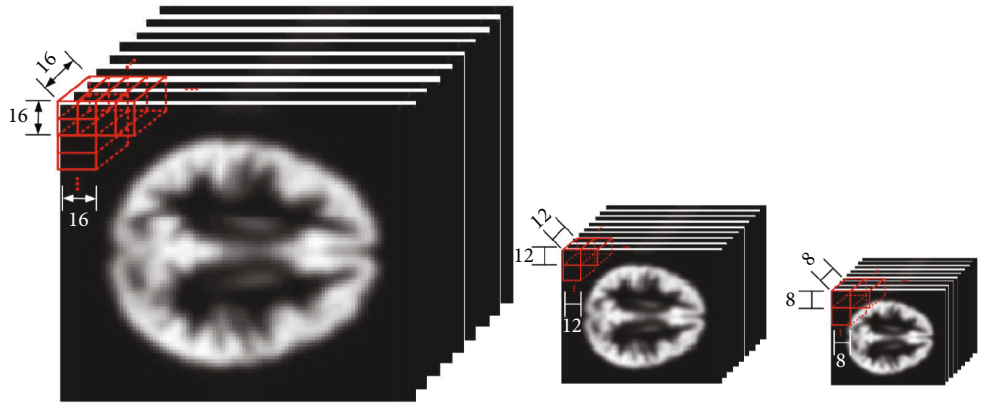

Figure 5: Schematic diagram of 3D local feature extraction.

the image description vector at each resolution, take the image description vector at each resolution as a feature channel so that three resolutions correspond to three feature channels and then fuse on the three feature channels to form the final decision.

In the test process, the first step is to extract features according to the feature extraction method mentioned in the training process. Then, after obtaining the feature description matrix of the image, the test image is represented by the visual word bank obtained during the training process. Similarly, in the process of representation, the test image is divided into subregions along three directions, and after each region is represented, the description vectors of all subregions are connected to get the final description vector. This description vector is used to classify the test image with the trained SVM classifier.

The following will introduce in detail local feature extraction and codebook construction, multiscale image partition and image representation, SVM classifier training and testing, etc.

3.2. Local Feature Extraction and Codebook Construction. In the stage of image local feature extraction, we first process the image to some extent, that is, downsampling processing, which is used to create three images with different resolutions. Here, we choose a sampling factor of 2, which means that the length, width, and height of the next resolution image are half of the length, width, and height of the adjacent previous resolution image.

Figure 5 shows the feature extraction method of "multiresolution three-dimensional pyramid" algorithm in this paper. Because the 3D image is rich in a large amount of local information, this paper adopts the feature extraction method of dense sampling. At the same time, we extract local image blocks with different sizes according to the different resolution of the image. For the image with the highest resolution, that is, the original image, we adopt a $16 \times 16 \times 16$ partition mode, and the overlap between two adjacent image blocks is 1/2 of the block size. For the image with the middle resolution, we use the partition mode of $12 \times 12 \times 12$, and the overlap between two adjacent image blocks is 1/2 of the block size. For the image with the lowest resolution, we use $8 \times 8 \times 8$ partition, and the overlap between two adjacent image blocks is 1/2 of the block size.

After the local region is obtained, the three-dimensional feature description operator proposed in the previous chapter is used to describe the three-dimensional feature of the local region. The next section will compare the algorithm performance and efficiency with 3D-SIFT description operator. After the extracted image blocks are described by using three-dimensional feature description, the local image features are clustered, and the k-means clustering algorithm is adopted to construct a visual word library, and the corresponding clustering center is the embodiment of codebook in the visual word library.

3.3. Multiscale Image Partition and Image Representation. So, in order to make better use of the spatial layout of the image and describe the information contained in the image in space, especially the information in three-dimensional space more effectively, similar to the "spatial pyramid matching" algorithm, in our "multiresolution three-dimensional spatial pyramid" method, different scales are used to divide the image. Then, compared with the "spatial pyramid matching" algorithm, our proposed method has mainly improved in these two places. The first is that the "spatial pyramid matching" algorithm is applied to an image with one resolution. Then, it divides the image from coarse to fine and multiscale, but our proposed algorithm gets multiresolution image by downsampling the original image first and then constructs a multiresolution image pyramid. At the same time, we use different scales to divide the images with different resolutions. Because of creating images with different resolutions, it not only enhances the discrimination of image features, but also has better robustness to scale changes. Secondly, the "spatial pyramid matching" algorithm is only a mesh division on the two-dimensional plane when segmenting the image, so it is not enough to use only the two-dimensional information of the image in the process of classification and recognition of the three-dimensional image. Therefore, we mesh images in three directions, which can make full use of the unique three-dimensional spatial information between three-dimensional image features and achieve the purpose of improving classification performance.

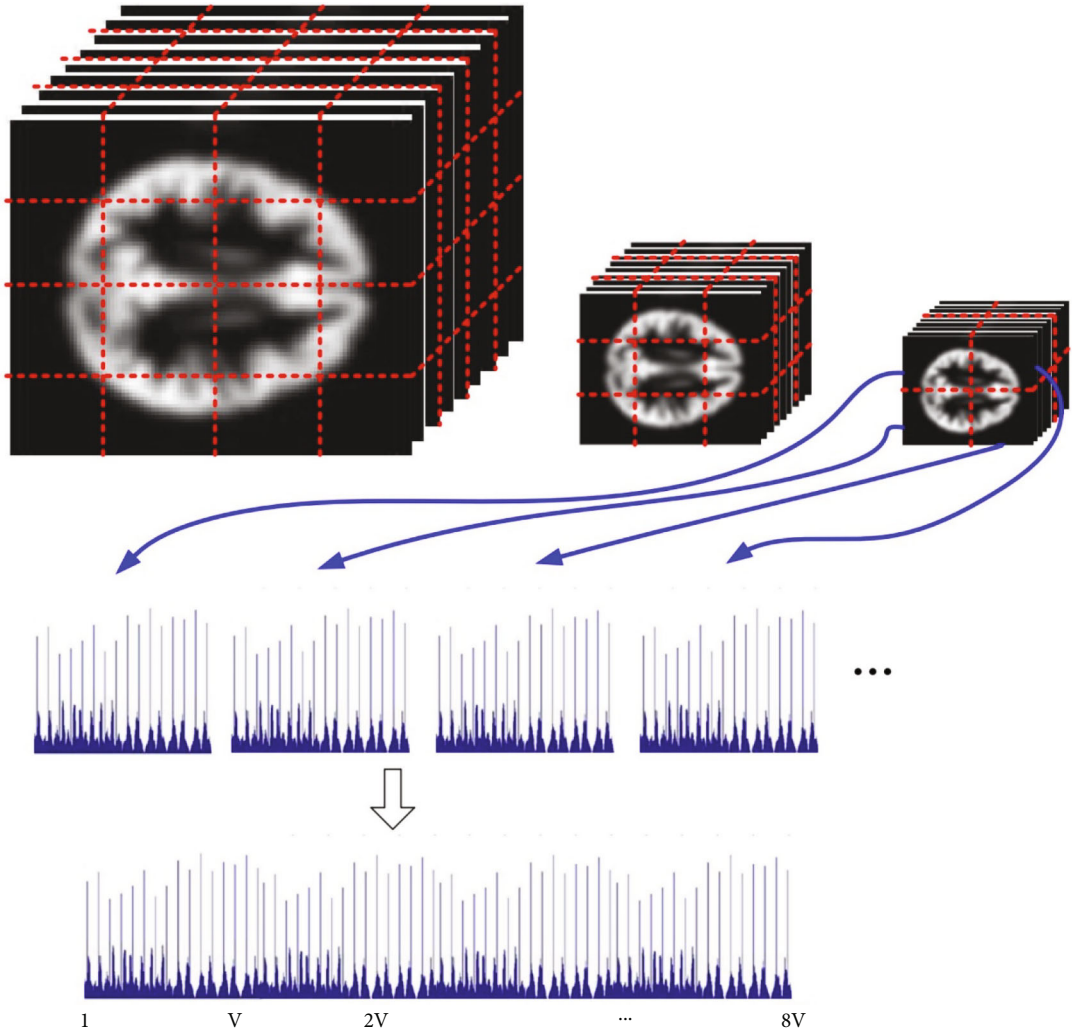

Figure 6: Schematic diagram of pyramid division in three-dimensional space.

In the way of dividing in three directions, the image is divided into different cube subregions. For images with different resolutions, we use different partition scales. Here, we divide the highest resolution image into $4 \times 4 \times 4$ cube subregions, the middle resolution image into $3 \times 3 \times 3$ cube subregions, and the lowest resolution image into $2 \times 2 \times 2$ cube subregions.

After using multiple scales to divide the spatial regions to a certain extent, we use a method similar to "feature bag" to represent each spatial region and then directly connect the vectors of all spatial regions of the image at this resolution to form the feature description of the image at this resolution. Taking the image at the lowest resolution as an example, the connection mode of description vectors under each subregion is illustrated, where V represents the size of visual word bank. Because the image at the lowest resolution is divided into sub-regions in a way of $2 \times 2 \times 2$, the dimension of description vectors obtained for the lowest resolution is 8 V.

3.4. SVM Classifier and Feature Fusion. For three-dimensional image classification and recognition, we use nonlinear SVM and choose to use the radical basis function (RBF) kernel in the SVM process. The definition is as follows:

$$K\left(V_i, V_j\right) = \exp\left(-\frac{1}{\gamma}\sum_{ch=1}^{3}\beta_{ch}D_{RBF}^{ch}\left(V_i^{ch}, V_j^{ch}\right)\right). \quad (11)$$

In this paper, images with three resolutions correspond to three feature channels, so $ch = 1, 2, 3$. V_i and V_j denote the i-th and j-th training images, and V_i^{ch} and V_j^{ch} denote the corresponding feature description vectors on the ch-th feature channel of the i-th and j-th training images. $\beta = \{\beta_1, \beta_2, \beta_3\}$ is the mixing coefficients of feature fusion, and their values can be obtained through training. It is shown in Figure 6.

D_{RBF}^{ch} represents the RBF kernel on the ch-th feature channel, which is defined as follows:

$$D_{RBF}^{ch}\left(V_i^{ch}, V_j^{ch}\right) = \left\|V_i^{ch} - V_j^{ch}\right\|^2. \quad (12)$$

γ is defined as follows:

$$\gamma = \left(\sum_{i=1}^{N} \sum_{j=1}^{N} \sum_{ch=1}^{3} \beta_{ch} D_{RBF}^{ch} \left(V_i^{ch}, V_j^{ch} \right) \right) / N, \tag{13}$$

where N represents the number of training samples.

Next, the SVM classifier is trained for classification, so all the parameters involved in it can be obtained by training the classifier. Then, after obtaining the classifier of SVM, for a test image X, its final discriminant function is defined as follows:

$$y(x) = \arg\max_{c=1,2} \left(K(x)^T \alpha_c + b_c \right). \tag{14}$$

In the formula, $K(x) = (K(V_1, V_x), \cdots, K(V_N, V_x))$, α represents the weight parameter obtained by learning and training in the training process, and B represents the threshold parameter obtained in the training and learning process. Y corresponds to the category of test image X.

In this way, the three-dimensional image classification and recognition framework of "multiresolution three-dimensional pyramid" based on three-dimensional feature extraction algorithm has been built.

4. Experiment and Analysis

4.1. Data Acquisition and Preprocessing. We classify and identify the gender information contained in magnetic resonance images on three carefully selected databases; these three databases are from Beijing, Cambridge, and Oulu. The subjects in the data are all young adults, and the average age of the subjects in each data center is not much different, which basically eliminates the influence of age factors on each data center.

The Beijing database included 70 healthy men (mean age 21.2 years, ranging from 18 to 26 years) and 70 healthy women (mean age 20.6 years, ranging from 18 to 25 years). All subjects were right-handed. These subjects were recruited from the State Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University, and all of them agreed and volunteered before scanning. The data acquisition equipment is Siemens 3T magnetic resonance imaging system. The Cambridge database included 75 healthy men (mean age 20.9 years, ranging from 18 to 30 years) and 123 healthy women (mean age 21.1 years, ranging from 18 to 30 years), of whom 86.4% were right-handed and 13.6% were left-handed. Oulu's database contains 37 male (average age 21.4 years, ranging from 20 to 23 years old) and 66 female (average age 21.6 years, ranging from 20 to 22 years old) healthy subjects, of which 89.4% are right-handed and 11.6% are left-handed. All subjects had no history of psychosis and nervous system diseases, alcohol dependence, and drug treatment and no serious head injury. All the data in this study were published on the 1000 Functional Connections Project (http://www.nitrc.org/projects/fcon_1000). The information of the subjects in each data center is shown in the following Table 1.

Table 1: Information on the number of people in each data center.

	Number of women	Number of males	Right-handed rate
Beijing	70	70	100%
Cambridge	123	75	86.4%
Oulu	66	37	89.4%

High resolution T1-weighted images were obtained with the following parameters: pulse repetition time of 2530 ms, echo time of 3.39 ms, slice thickness of 1.33 mm, reversal angle of 7°, field of view of $256 \times 256\ mm^2$, plane resolution of 256×192, and 128 slices of vector scanning. The preprocessing of structural images is carried out on SPM8 software (Wellcome Department Imaging Neuroscience, University College London, UK; Http://http://www.fil.ion.ucl.ac.uk/spm). The first step is to use the "New Segment" toolkit in SPM8 toolkit to segment the original image, so as to obtain the images of gray matter, white matter, and cerebrospinal fluid tissue. The number of voxels belonging to gray matter, white matter, and cerebrospinal fluid was determined in the subject space. The total volume of the tissue was obtained by multiplying the count of each tissue type by the voxel size ($1 \times 1 \times 1.33\ mm^3$). The whole brain volume is obtained by adding the volumes of gray matter, white matter, and cerebrospinal fluid.

Use the DARTEL (diffeomorphic anatomical registration through exponentiated lie algebra) toolkit to create brain templates for specific populations. DARTEL toolkit is newly developed by John Ashburner of Functional Imaging Laboratory (FIL), King's College London, UK. It is a set of algorithms and tools integrated in SPM8 for accurate registration of brain images between subjects. Compared with the original registration method between subjects in SPM, this method can obtain higher accuracy. The use experience in FIL can show that the analysis of VBM based on DARTEL method can not only obtain more accurate location, but also improve sensitivity. Then, not limited to this, DARTEL Toolkit has added a brand-new function, that is to say, teeth can create a brain template of structural images. DARTEL firstly uses the registered images of all subjects to generate a template. Then, the images of each subject are registered to the template. Then, using these images which have been registered to the template, a new template is generated again, and then the images of each subject are re-registered to this new template. The operation is repeated until a better registration result between subjects is obtained, thus forming the final template file, which is generally Template6. n_{ii} file. The last step is to normalize the gray matter and white matter in the subject space to MNI space by using the template file produced by DARTEL and resample them into voxels with the size of $2 \times 2 \times 2\ mm^3$. Then, the normalized gray matter image is smoothed by Gaussian kernel with a FWHM of 8 mm. In order to reduce the possible boundary influence between different tissue types, we eliminate voxels with gray scale less than 0.1 from gray matter images.

The preprocessing flow chart is shown in Figure 7. At present, there are only prior probability maps of gray matter,

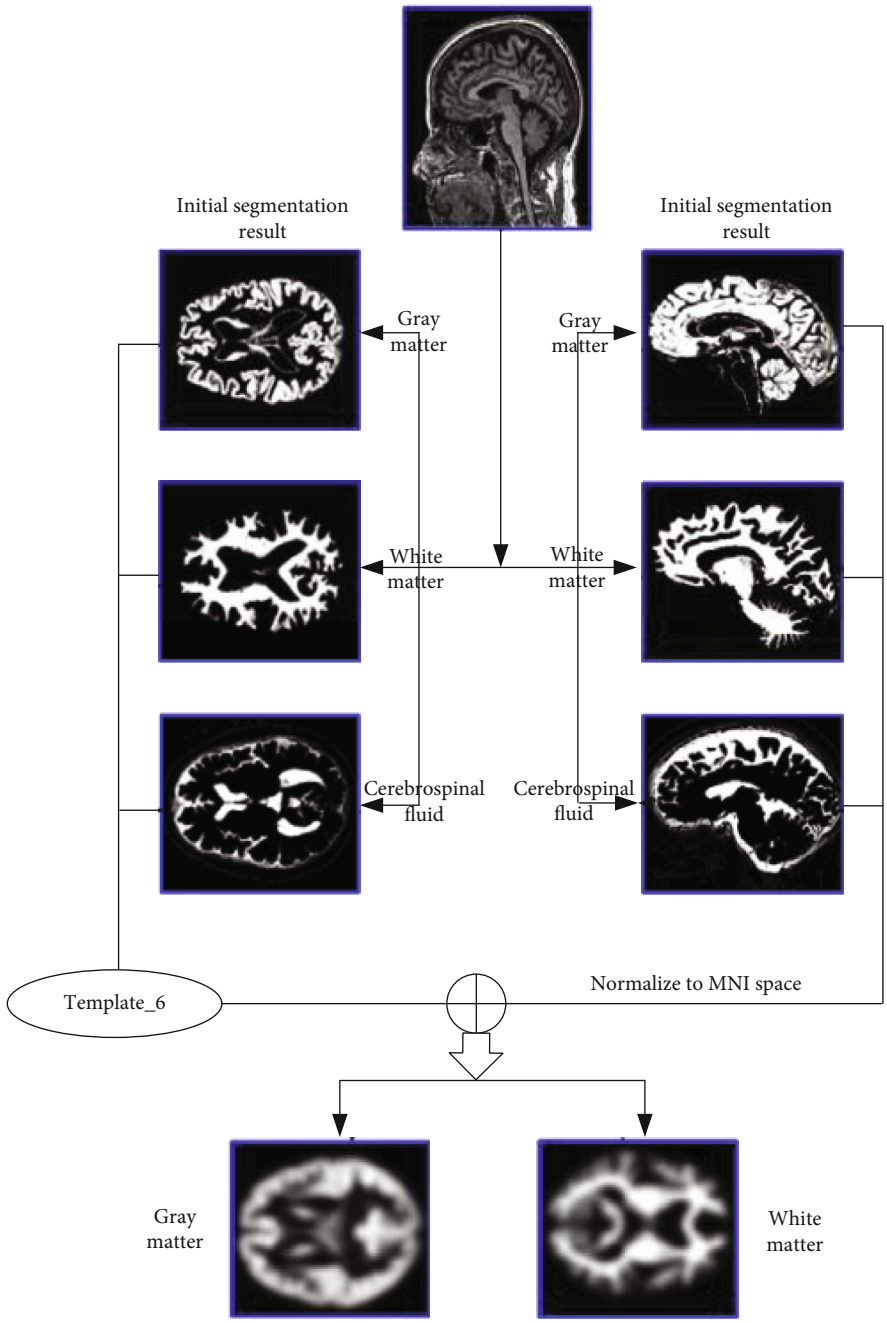

Figure 7: DARTEL preprocessing flow chart.

white matter, and cerebrospinal fluid in DARTEL results, and the prior probability maps of bone and other tissues are missing, so it is difficult to segment cerebrospinal fluid well in the end. In this way, there are only gray matter files and white matter files in DARTEL results, as shown in Figure 7. However, in the following classification and recognition of this paper, gray matter information is mainly used, so this result will not bring any problems to the research work of this paper.

In the preprocessing process of Figure 7, the original results include gray matter, white matter, and cerebrospinal fluid, but the classification algorithm used in this paper can use "white matter" and "gray matter" images to study the classification method, and the classification and recognition effect of "white matter" and "gray matter" in this paper is ideal. Therefore, for the preprocessing results in Figure 7, in order to improve the effect of the classification algorithm, less operation cost is achieved to achieve the ultimate goal.

4.2. Experimental Results and Analysis. The performance of the algorithm is tested on three human brain magnetic resonance image databases, including the classification accuracy of the algorithm, the parameters affecting the accuracy of the algorithm, and the calculation time of the operator.

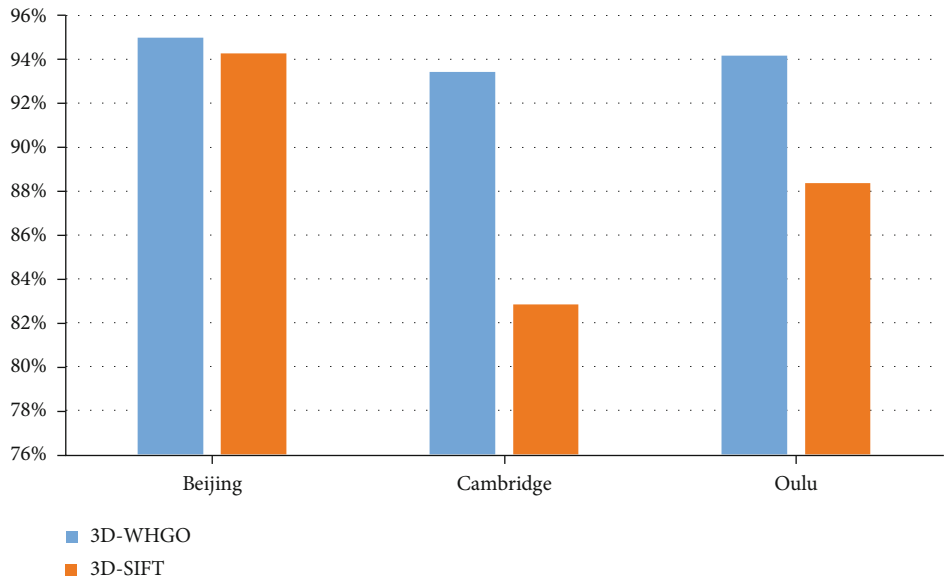

Figure 8: Comparison of recognition rates between 3D-WHGO and 3D-SIFT in various data centers.

Because the number of samples in each center is not particularly large, in order to ensure sufficient training set, we use leave-one-out cross-validation (LOOCV) method to carry out experiments. That is to say, in each central database, one sample is set aside as a test set, and all other samples are used as training sets. The correct rate of each sample is counted to get the correct rate of recognition in the whole database. Cross-validation is another model selection method. It is different from the model selection method introduced earlier. It is a model selection method that can directly estimate generalization error without any presupposition. Because there is no presupposition, it can be applied to various model selection, so it has universality of application, and because of its simplicity of operation, it is considered an effective model selection method.

The method references used in different databases all use this rule for classification training of test set and training set. Generally, it is related to the scale of the database, which is large in scale and long in running time, while the running time is small in the same way. The algorithm should be a semisupervised learning process. At the beginning, all samples are downsampled to get images with three resolutions. In order to compare the performance of the operators, we use 3D-WHGO and 3D-SIFT descriptors in the process of feature extraction. Then, cluster analysis is carried out to construct a visual word library, and then each sample is represented by the codebook in the visual word library, which adopts the pyramid division of three-dimensional space. Because these processes do not involve the label information of samples, they belong to unsupervised learning process. For classification, the training set and the test set are separated, and the label information of samples is used in the construction of classifier, which belongs to supervised learning process, so the whole algorithm framework belongs to semisupervised learning process. For the fusion of three resolution images at the decision level, we adopt a strategy of fixing a set of fusion parameters, carrying out the experiment of leaving one at a time, changing the parameters until the best recognition result is obtained, and recording the parameters as the fusion parameters of multi-resolution images.

4.2.1. Performance Test of Feature Description Operator. According to our proposed algorithm framework, we compare the performance of 3D-WHGO and 3D-SIFT feature description operators under the same experimental conditions, that is, we use the "multiresolution 3D pyramid" algorithm proposed in this paper to test the performance of 3D-WHGO and 3D-SIFT feature description operators, mainly comparing the recognition rate and calculation time of operators. When comparing the recognition rate, we use the single variable method, that is, the two feature description operators are classified and recognized in each database in the algorithm framework with the same parameters, and then the classification accuracy of the two feature description operators in three central databases is compared. When comparing the computation time of the operators, we choose the same size image blocks, compute the 3D-WHGO and 3D-SIFT feature descriptors, respectively, count the time consumed by the two descriptors, and then get the comparison of the computation time of the two three-dimensional feature description operators. The specific comparison results are as follows, in which Figure 8 shows the comparison of recognition rates and Table 2 shows the comparison of calculation time.

From the above results, we can see that our proposed 3D-WHGO feature descriptor is better than the previous 3D-SIFT feature descriptor in all three central databases. Although the two feature descriptors get almost the same recognition results in Beijing data center, our 3D-WHGO feature descriptor has much better classification performance than 3D-SIFT feature descriptor in the other two data centers.

Because the same experimental parameters are used in the experiments, the main reason for the difference in

Table 2: Comparison of time consumption between 3D-WHGO and 3D-SIFT in calculating a magnetic resonance image.

	3D-WHGO	3D-SIFT
Calculating time	37.45 s	1868.19 s

classification performance is the descriptive ability of feature descriptors. 3D-WHGO is constructed by adding the third dimensional spatiotemporal information on the basis of WHGO feature descriptor, and the frequency information of gradient size and gradient direction is used in the construction process, while 3D-SIFT is obtained by three-dimensional SIFT feature descriptor, and its feature description mode is basically consistent with SIFT feature descriptor. Therefore, in the two-dimensional case, WHGO feature description operator uses more information than SIFT operator and then obtains better image classification and recognition results. Therefore, in three-dimensional images, because of the addition of space-time dimension, the increase of information is not a simple multiple relationship, so when extracting three-dimensional features, more effective classification information will be obtained, which also leads to the performance of 3D-WHGO feature description operator in classification accuracy compared with 3D-SIFT feature description. In this paper, three kinds of data are analyzed, and good application results are obtained, while the experimental results in Beijing database are better. In the three databases, the amount of data is relatively sufficient, and each 3D image processing has similar running time and recognition effect. It can be seen in Table 2 that 3D-WHGO algorithm has good performance.

From Table 2, we can see that 3D-WHGO feature descriptor has obvious advantages in computing speed. The computational time of 3D-SIFT descriptor is almost 60 times that of 3D-WHGO descriptor when calculating a magnetic resonance image of human brain. This is of practical significance in concrete application, because it may take half an hour to one hour to collect a human brain magnetic resonance image, and the time for image classification and recognition by 3D-WHGO feature description operator is far shorter than that for collecting an image. To some extent, this is also a real-time embodiment. And 3D-SIFT will take a long time, so it cannot meet the real-time requirements.

Compared with 3D-SIFT, 3D-WHGO has a great improvement in two aspects, which is not difficult to see from the calculation time consumption and the classification and recognition accuracy. As far as the accuracy of classification and recognition is concerned, 3D-WHGO not only uses the gradient size and gradient direction information obtained in 3D space, but also uses the frequency information of gradient direction in 3D space and at the same time uses gradient size for weighting, which makes 3D-WHGO use more detailed information than 3D-SIFT. Therefore, it is not difficult to understand that 3D-WHGO can get better classification and recognition accuracy. 3D-WHGO also takes less time to calculate a magnetic resonance image of human brain. There are two reasons: First, 3D-SIFT is obtained on the basis of SIFT, which is a point-centered calculation method, while 3D-WHGO is an image block-centered calculation method, which improves the calculation efficiency. On the other hand, although 3D-WHGO uses the frequency information in the gradient direction, it is almost time-consuming to count the frequency information in the gradient direction, which will not increase the calculation time. This explains the phenomenon that 3D-SIFT has poor performance instead of long computing time.

From the above analysis, we can get the conclusion that our 3D-WHGO feature description operator makes use of more gradient direction and frequency information in spatiotemporal dimensions, so it can get better classification and recognition results. At the same time, the computational cost is not large. Compared with 3D-SIFT feature description operator, 3D-WHGO feature description operator can basically meet the real-time requirements in practical applications.

4.2.2. Performance Test of Classification and Recognition Framework. On the basis of "spatial pyramid matching" algorithm, combined with the characteristics of three-dimensional images and three-dimensional feature extraction algorithm, aiming at the problem of three-dimensional image classification and recognition, we put forward an image classification and recognition algorithm framework based on three-dimensional feature extraction algorithm-"multiresolution three-dimensional spatial pyramid" algorithm for the first time. This is the first algorithm framework for 3D image classification and recognition in the field of pattern recognition. In the proposed algorithm framework, we divide the three-dimensional image into space when we represent the three-dimensional image based on codebook and further utilize the spatial information between image features on the basis of the two-dimensional space division, which is unique to the three-dimensional image. Therefore, it is of great significance for 3D image classification and recognition.

When we test the performance of the algorithm framework, The single variable method is also selected, the 3D-WHGO feature description operator proposed in this paper is selected as the local feature description method, and experiments are carried out on the basis of traditional "feature bag," "spatial pyramid matching" algorithm, and "multiresolution 3D spatial pyramid matching algorithm," and the recognition results are obtained by using three classification frameworks in each data center. The comparison results are shown in Figure 9.

From Figure 9, we can see that the traditional "feature bag" method has achieved good results for image classification and recognition to a great extent. However, as mentioned above, the "feature bag" method regards features as disordered sets, ignoring the spatial information between features. To a certain extent, "spatial pyramid matching" algorithm makes use of the two-dimensional spatial information between features by dividing the space of two-dimensional images. Using the "spatial pyramid matching" algorithm really improves the performance. However, because the "spatial pyramid matching" algorithm uses the two-dimensional spatial information between features, but

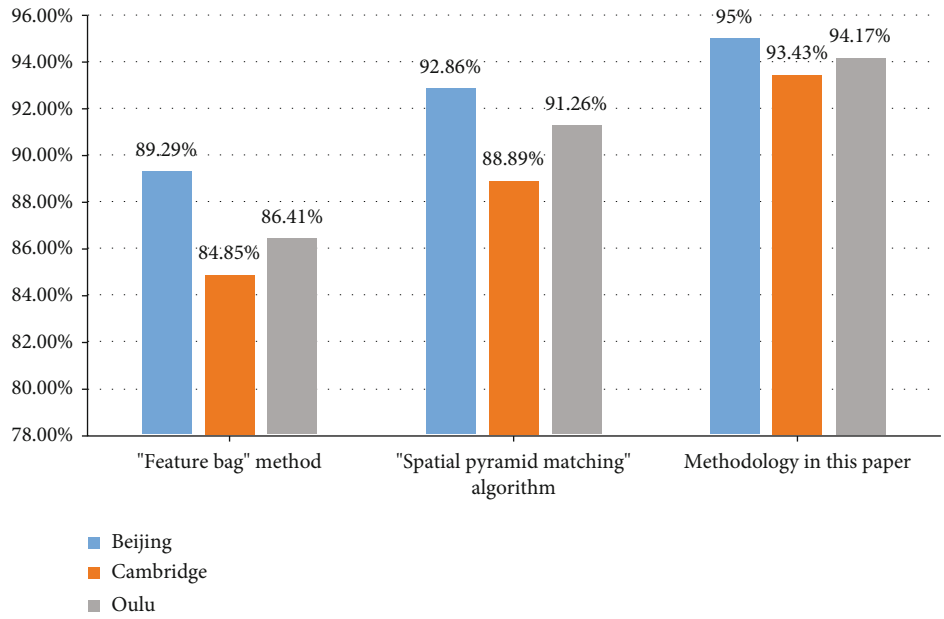

Figure 9: Performance comparison of classification and recognition algorithm framework.

does not reflect the three-dimensional spatial information of three-dimensional images, the "spatial pyramid matching" algorithm cannot fully meet the requirements of three-dimensional image classification and recognition. The "multi-resolution three-dimensional pyramid" algorithm proposed in this paper effectively utilizes the spatial information of three-dimensional images and makes full use of the three-dimensional spatial relationship between features by dividing the three-dimensional images. It is precisely because of the use of this information that the algorithm proposed in this paper has achieved ideal classification performance compared with previous methods, and it also confirms the effectiveness of the image classification and recognition framework based on 3D feature extraction algorithm proposed in this paper.

4.2.3. Classifier Fusion Parameter Selection. For the method of multiresolution image fusion at decision level, we adopt LP-β strategy, that is, for each feature channel, it corresponds to a weighting factor β, that is, the weighting factor corresponding to the original image is β_1, the weighting factor corresponding to the intermediate resolution image is β_2, and the weighting factor of the lowest resolution image is β_3, which is related as follows:

$$\beta_1 + \beta_2 + \beta_3 = 1. \tag{15}$$

In the experimental process, we find the optimal fusion parameters by iterating through β_1 and β_2. Specifically, β_1 and β_2 are traversed from 0 to 1 with a step size of 0.05 in the experimental process, and at the same time, Equation (15) is guaranteed, and the classification accuracy of each group of parameters β is counted to find the optimal fusion parameter corresponding to each data center, and the classification recognition results under each data center can be seen from the figure that the original image occupies more weight in the classification, which is consistent with our cognitive experience. At the same time, because the decision information of other resolution images is added, the overall recognition accuracy is improved, which also shows that the multiresolution information is fused, which makes more effective information be integrated into the classification recognition process, so the classification recognition accuracy is improved.

5. Conclusion

Based on the three-dimensional feature extraction algorithm, a "multiresolution three-dimensional pyramid" algorithm is proposed in this paper. This algorithm is based on the three-dimensional feature extraction operator and the "spatial pyramid matching" algorithm and fuses the special spatial information of three-dimensional images. When the image is expressed based on the "feature bag" method, the image is divided into three-dimensional spaces to make more use of the spatial information between features. But it is not limited to this point. We introduce the idea of multiresolution into our algorithm framework and use multiresolution fusion to form the final classifier when making decisions. Therefore, the whole framework of "multiresolution three-dimensional pyramid" algorithm based on three-dimensional feature extraction is formed.

This paper uses the data of three data centers to test the performance of the proposed three-dimensional feature extraction algorithm, through the data of human brain magnetic resonance images of male and female gender information classification and recognition, and get a relatively ideal classification and recognition results. It not only proves the effectiveness of our proposed "multi-resolution 3D pyramid" algorithm for 3D image classification and recognition but

also proves the advantages of our proposed 3D-WHGO feature descriptor compared with the current 3D-SIFT descriptor in classification performance and computation time. The experimental results show that there are gender differences in the gray matter of magnetic resonance images of human brain structure and this information is unrecognizable to human beings. At the same time, the method in this paper also confirms that there are individual differences in human gender information in magnetic resonance images of human brain.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

Acknowledgments

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Retraction

Retracted: Function Extraction Based on CFPS and Digital Financial Index: Data Mining Techniques for Prognosis of Operational Risks of Financial Institutions

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] B. Li and G. Li, "Function Extraction Based on CFPS and Digital Financial Index: Data Mining Techniques for Prognosis of Operational Risks of Financial Institutions," *Journal of Sensors*, vol. 2022, Article ID 9645142, 11 pages, 2022.

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Research Article

Function Extraction Based on CFPS and Digital Financial Index: Data Mining Techniques for Prognosis of Operational Risks of Financial Institutions

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Financial deregulation, financial globalization, and the increasing variety and technological sophistication of the commodities offered by financial services have made the operations of financial institutions more complex. Compared with credit risk and market risk, financial institutions' transaction risk management plays an increasingly important role in financial practice. As an emerging technology, big data mining technology has a unique advantage in optimizing the processing and management of large amounts of data. Big data mining technology not only has the common functions of finding, comprehensively managing all kinds of information, collecting and analyzing data, and conducting statistics but also should have the ability to process information that is hidden and useful in the database through data mining technology. Based on CFPS and data mining technology, this paper analyzes the operational risk of financial institutions, analyzes the causes of the operational risk of financial institutions, discusses the measures to avoid the operational risk of financial institutions, and draws corresponding conclusions.

1. Introduction

In today's globalized economy, financial risk affects the whole market economy and its possible harm cannot be underestimated. Financial institutions play an important role in the financial system, so it is necessary to study the operational risks of financial institutions and take corresponding preventive and control measures. Operational risk is one of the common risks of financial institutions. In many financial institutions, the losses caused by operational risks are significantly greater than credit risks and market risks. As financial activities become increasingly complex, operational risk management plays an increasingly important role in the operations of financial institutions. Operational risk is becoming an increasingly important risk factor for financial institutions worldwide. The focus is on identifying, measuring, and monitoring operational risk. Operational risk refers to fluctuations in customer revenues or cash flows, lack of adequate internal controls, system or control failures, and loss of control of events at financial institutions. Operational risk management typically involves identifying the financial institution's risks, assessing the financial institution's risks, ensuring that an effective capital planning and monitoring program is in place, monitoring risks, risk exposures, and corresponding capital requirements on an ongoing basis, taking steps to control or reduce risk exposures, and reporting to senior management and the Board of Directors on the financial institution's risk exposures and capital position. A sound internal governance structure is the foundation for effective operational risk management, and therefore, internal controls should be incorporated into the day-to-day operations of a financial institution to ensure that it conducts its business activities as efficiently as possible and provides reliable, timely, and complete information while complying with applicable laws and regulations. Although operational risk has not been studied for a long time, in recent years, it has been listed as a major risk that financial institutions need to face simultaneously, as well as market

risk and credit risk. Given the complexity of operational risks and the severity of damage, effective prevention of operational risks has become an active issue for financial institutions. Operational risk assessment rules facilitate, to some extent, the analysis of the operational risk profile of financial institutions, develop appropriate operational risk management strategies, and provide a theoretical basis for financial institutions to identify risks and conduct risk analysis when designing overall operational risk management [1].

In the field of work risk research in financial institutions, the maturity of data collection methods and approaches provides a wide scope for the application of workplace risk management techniques. The collection of data from a large number of sources provides us with valid data to help us analyze, develop, and implement such methods. This allows us to analyze existing facts more rationally and to predict and control the future more accurately. The rapid development and attention of professionals and scholars in various fields have been made possible by the rapid development of computer technology and its widespread availability throughout the world. The main technical conditions are as follows: first, the development of technology and business capabilities has enabled the public sector and individuals to place greater emphasis on mining data. Secondly, in addition to improving data management tools, improving the efficiency of information utilization and reducing storage costs have played an important role in the development of data extraction technologies. In addition, after decades of theoretical and technical development, statistics has been successfully applied in many fields, laying the foundation for data exploitation and contributing significantly to the development of this approach. The purpose of this paper is to analyze and study the methods of processing and analyzing job risk data by taking advantage of the powerful advantages of data extraction techniques for job risk analysis to fill the gaps in job risk data. The analysis of job risk data features provides substantial support for the application of data extraction techniques in the context of job risk [2].

In the process of analyzing the business risks of financial institutions, this paper uses data extraction techniques in the data processing process to analyze the business risks of financial institutions through data extraction and CFPS analysis methods to analyze the development background of financial institutions, the causes of job risks, and the exploration of measures.

2. Research Background

2.1. Overview of Data Mining Technology. The latest foreign big data analysis and its mining methods in the field of large databases related to the scope and content of research have been very mature and extensive and have achieved many significant and representative technical results. The ongoing research on how to use knowledge and data systems in database modeling and related services has largely led to a number of fairly significant technical advances with some important representative values so far [3]. The academic results can be summarized as follows: methods such as induction and analysis oriented to the relational attributes of data features are used to find relational attribute differentiation rules and feature rules for data attributes in relational database models. In order to be able to go deeper into solving the most complex uncertainty problems in Dury rough data collection theory, evidence-theoretic models and fuzzy set theory are also applicable to the computation and analysis of databases, leading to practical models and technical applications of phase research methods. Compared with other similar research and practice projects jointly conducted abroad, the Chinese team members in China have been late in developing the ability to quickly analyze and mine network data and to continuously discover and acquire the value of network knowledge and have been late in transforming some technical research results and carrying out research practice and application work. It has not been further developed to form a more complete and mature force of such a technical system. Currently, most of the professionals or researchers engaged in research or development work are concentrated in universities and some research institutes or companies. The most important recent research results are summarized as follows: (1) an in-depth study by the Institute of Systems Engineering of the National Natural Science Foundation of China in Beijing shows that the method and its practical application in the field of knowledge system detection are not clear; (2) an in-depth theoretical study of data cubic algebra; (3) optimization and improvement of the rule-building algorithm of Jilin University, including East China University of Science and Technology, Beijing University, Fudan Zhejiang University, China University of Technology, and the Institute of Mathematics of the Chinese Academy of Sciences efforts; (4) based on Nanjing University, based on Sichuan University, based on Shanghai Jiao Tong University, and so on to carry out the knowledge resource discovery mechanism and for unstructured data network data mining problems such as empirical research; and (5) the Chinese Academy of Sciences Institute of Computing Technology, Tsinghua University Chinese Academy of Sciences group of professors, Shi Zhongzhi, and other multiperson data mining tool designed and developed a multiperson strategy knowledge discovery analysis platform, using decision tree algorithm which can detect all kinds of abnormal situation information in local tax systems such as Guangdong to provide services to taxpayers [4].

2.2. Review of Operational Risk in Financial Institutions. Compared with foreign research on operational risk, operational risk analysis in China still remains at the stage of scholarly research. Due to the property rights and information disclosure system of commercial financial institutions in China, many of these cases involve fraudulent acts by internal and external parties and involve the reputation of commercial financial institutions, so most financial institutions know little about this aspect and are reluctant to disclose it [5]. In addition, Chinese trade and financial institutions do not have specific loss data and reports for risk management operations or transactions. As a result, operational risk has not improved in our practice. However, after

China's accession to the World Trade Organization, the economic system has shifted from a planned economy to a market economy, and Chinese trade and financial institutions have continued to reform. Operational risk will play a very important role in Chinese business and financial institutions. In the past two years, more and more experts and scholars have started to focus on this area. In China, some scholars have applied data mining techniques in the financial field, such as Yang Tian, Huang Yijing, Liu Fei, and Luo Xiang, who analyzed the application of data mining techniques in the early warning system of financial crisis of listed companies. However, the application of data extraction techniques in the field of workplace risk is still very low [6]. Except for the use of hybrid models based on expert rules and genetic algorithms to share workplace risk, no Chinese scientists have applied data mining techniques to workplace risk. Therefore, combining data extraction methods with financial operational risk research has a very broad research area and great research value. In contrast, international research on operational risk is more systematic and, to some extent, scientifically based. Many professionals and scientists are assessing job-related risks. Mr. Chase has developed an effective credit assessment model using a hybrid data extraction approach of clusters and neural networks [7]. Beisens et al. investigated credit risk assessment using neural networks and decision tables. Gene combined neural network knowledge and transactions to predict the interest rates of corporate bonds and government debt. Although his integrated model is not very successful in predicting North Korean interest rates, it has a significant advantage over stochastic models in predicting U.S. interest rates. Corporate bonds are valued on a summary and return basis, allowing for a better assessment of the bond's condition. Using a similar rule, these bonds are valued at previous interest rates. Hashimi et al. predicted the financial institution participation model using a neural network model that takes data from over 200 financial institutions as input to the neural network and decomposes it into 28 liquidity and credit risk factors. The model correctly classified 96% of the data from all four financial institution ownership structure tests with an estimated accuracy of 11%. The neural technique was used to obtain better results in the design of liquidity analysis and decision models [8].

3. Research Methods and Materials

3.1. Main Concepts

3.1.1. Data Mining Techniques

(1) The Meaning of Data Mining Technology. The data extraction method is a decision support process of data collection center to the research object. Data mining is not a single discipline, but a mixture of many disciplines. Through data mining, researchers can fully exploit empirical and theoretical knowledge to provide decision support, which is also the task of data mining. The obtained knowledge can supplement the existing knowledge system, support and help decision makers in the decision-making process, and be stored in the relevant knowledge base as new knowledge. At present, only the initial application of data mining technology in the fields of finance, financial institutions, and geographic information systems is inseparable from the lack of core technology. Data mining is a continuous exchange process between human and machine with many closely related steps. The key steps are problem formulation, data selection, organization of identified data, model building, judgment, and interpretation, all of which are subject to an iterative process [9], as shown in Figure 1.

(2) The Main Processes of Data Mining Techniques. Data mining, as a deep data research and analysis method, is a process from proposing a solution to determining it. If this technology is applied to the system of predetermination and inspection of operational risks of financial institutions, it can improve the level of operational risk control of financial institutions and make the work twice as effective [10]. The main process of data mining technology is shown in Figure 2.

Step 1. Identifying data mining objects and targets: data mining target identification and finding are the first and the most important step in the data mining process. The final result cannot be predicted, but the research problem can be predicted by data mining.

Step 2. Data acquisition: data collection is laborious and requires a lot of time and effort. It requires the collector to carefully collect a variety of data and information in their daily educational activities, some of which are directly available and some of which must be found through research [11].

Step 3. Data preprocessing: this step converts the collected data into a data model, which is analyzed and modeled according to different algorithms, and therefore, different algorithms have different requirements for the data model [12].

Step 4. Data clustering mining: the data model is divided into several groups using cluster mining techniques. Words are classified based on similarity, and the greater the similarity, the more likely they are to be grouped together. This step is the process of selecting and implementing the clustering algorithm and the input data model [13].

Step 5. Analysis of clustering results: this process is to select and analyze the information mined from the clustered data and to judge the results of multiple sets of attributes [14].

Step 6. Application of knowledge: this is the final step; i.e., the useful information obtained in the previous step is applied to the prognosis of the operational risk of the financial institution, which leads to useful conclusions and enlightens the prognosis of the operational risk of the financial institution, which is the purpose of the thesis research [15].

3.1.2. CFPS and Digital Finance

(1) Meaning of CFPS. CFPS is the abbreviation of China Household Survey, which covers three dimensions: rural (household) infrastructure and environment, population, household income, and personal education, and reflects

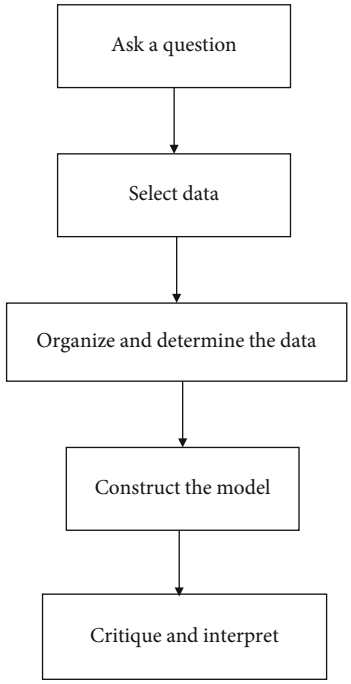

Figure 1: Steps of data mining techniques.

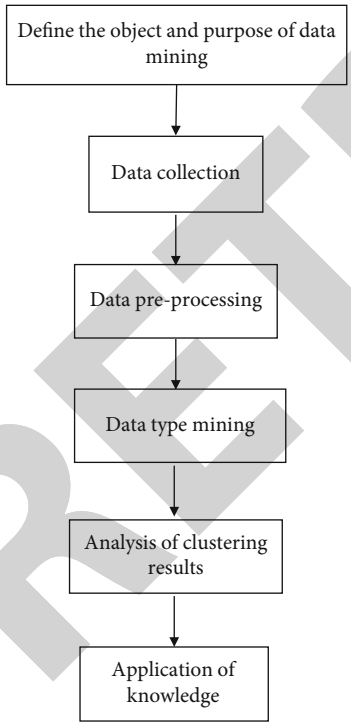

Figure 2: The main process of data mining techniques.

China's economic development and social changes in a more general way. Since it can fully reflect China's economic development and social changes, it is especially important for the research with financial markets, and in this paper, CFPS is used to analyze the impact of China's economic development and social changes on financial markets [16].

(2) Digital Finance. Digital finance, as a means of information dissemination, reduces information asymmetry and poor processing while reducing transaction costs. In particular, as an information channel to expand the scope and coverage of financial services and improve the quality of information, the effectiveness of information dissemination and the expansion of the scope of dissemination are fully considered when using new information technologies such as big data, cloud computing, and artificial intelligence [17].

3.2. Main Formula and Algorithm Flow

(1) According to clustering methods, algorithms based on density, grid, and model are not suitable for these small and medium data types, so this kind of data mining can be studied and analyzed according to the classical algorithms *k*-mean and *k*-center algorithms. According to the definition of the *k* algorithms, the number of categories required for the study can be expressed. The basic idea of these two classical *n* algorithms is to *k* divide individual objects into classes so that similar objects have high similarity and objects in different classes have low similarity. The mean value of each class is the reference value for the *k*-means algorithm, while the *k*-centroid algorithm uses the point object at the center of the class as the reference value to calculate the dissimilarity [18]. The *k*-centered algorithm has an advantage over the *k*-mean algorithm when outliers are present in the data objects, which is related to the fact that the center is insensitive to outliers and the mean is more sensitive to outliers. However, the *k*-centered algorithm is more complex than the k-mean algorithm. Assuming that the complexity of the *k*-mean algorithm is represented by *x*, we calculate

$$x = nkt, \tag{1}$$

where *n* denotes the number of classes and *t* denotes the number of iterations.

The complexity of the k-centered algorithm is denoted by *y*, and when the *k*-centered algorithm performs iterations, the complexity of the algorithm becomes

$$y = k(n-k)2x = nkty = k(n-k)2, \tag{2}$$

where *x* is the complexity of the *k*-mean algorithm and *y* is the complexity of the *k*-center algorithm.

(2) The main algorithm process: in the *k*-mean algorithm, the function LoadPatterns (Char∗fname) serves to load the sample data information into the process of the program, and the main purpose of this function is to read out the relevant information from the database file km.dat and convert the data in the file into the sample Patten[i][j] array [19].

The function RunKMeans() serves as the main procedure of the algorithm; the main procedure is to compare

the distance of all objects to the center of each cluster. Then, the objects are divided into the classes with the nearest class centers, and the cluster centers are calculated again according to the redivision, and if the class centers do not change in any way, then the clustering process is terminated [15].

The function InitClusters() functions as the initialization process of the class centers, and the function starts by using the first K data in the data sample as the starting class centers.

The ConvFlag is used as an identifier for whether the clustering is complete or not, the function ShowCenters() represents the cluster centers described by the algorithm, and the function ShowClusters() represents the identifier number of the samples described by the algorithm [20]. This is shown in Figure 3.

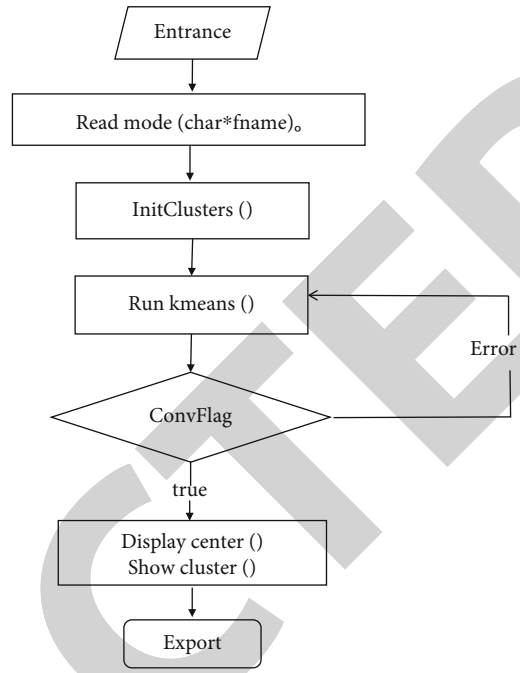

Figure 3: Flowchart of the algorithm.

4. Results and Discussion

4.1. Operational Risk Analysis of Financial Institutions. Through CFPS analysis and information processing technology of big data mining, the impact of China's economic development and social changes on the financial market has been analyzed and predicted, the current situation of the financial market has been summarized, and the causes and impacts of financial institutions' operational risks have been predicted through big data mining technology and analyzed as follows.

(1) The impact of changes in household income on the financial market: the analysis investigated the average income amount of urban and rural households in China from 2016 to 2022 and concluded that the increase in household income is very beneficial to the development of the financial market; the specific data are as follows: in 2016, the average income amount of urban residents in China was 124,000 yuan and 77,000 yuan in rural areas; in 2018, in urban residents in China, the average income amount is 136,000 yuan and 85,000 yuan in rural areas; in 2020, the average income amount of urban residents in China is 140,000 yuan and 88,000 yuan in rural areas; in 2022, the average income amount of urban residents in China is 157,000 yuan and 96,000 yuan in rural areas; from the data, it can be seen that the income of urban and rural residents in China is improving year by year, which means that as the income level increases, people are willing to invest in financial items such as savings and wealth management may increase, as shown in Figure 4

(2) The impact of the number of savings, loans, and other financial services on the financial market: the number of urban financial services is 245,060 in 2016, 256,000 in 2018, 266,940 in 2020, and 277,880 in 2022; the number of rural financial services is 189,045 in 2016, 195,400 in 2018 and 2020, 201755 in 2016, 201755 in 2018, 208110 in 2020, and 208110 in 2022; from the analysis of the data, it can be seen that the number of both urban and rural financial services is increasing year by year, which shows that the financial market is developing well, as shown in Figure 5

From the above analysis, it can be seen that with the increase in income of urban and rural residents and the significant increase in the number of financial business, there is a great opportunity for the development of China's financial market and financial institutions. But it is because of this opportunity that it also provides an opportunity for the occurrence of risk events of financial institutions.

(3) The relationship between the number of operational risk events of financial institutions and the number of financial operations: in 2016, the number of financial operations in China was 224,000 and the number of risk occurrences of financial institutions was 7,000; in 2018, the number of financial operations in China was 236,000 and the number of risk occurrences of financial institutions was 8,000; in 2020, the number of financial operations in China was 240,000 and the number of financial institutions' risk is 8800; the number of financial operations in China is 257000 in 2022, and the number of financial institution risk is 9600, which proves that the number of financial institutions' operational risk and the number of financial operations have roughly proportional growth relationship, but because the number of financial operations in China is gradually increasing, with the rising trend of financial operation risk, it is necessary to take reasonable measures. The number of financial operations and the number of financial businesses in China are increasing gradually, as shown in Figure 6

(4) Financial institutions' operational risk causation ratio: the main analysis of the three main causation

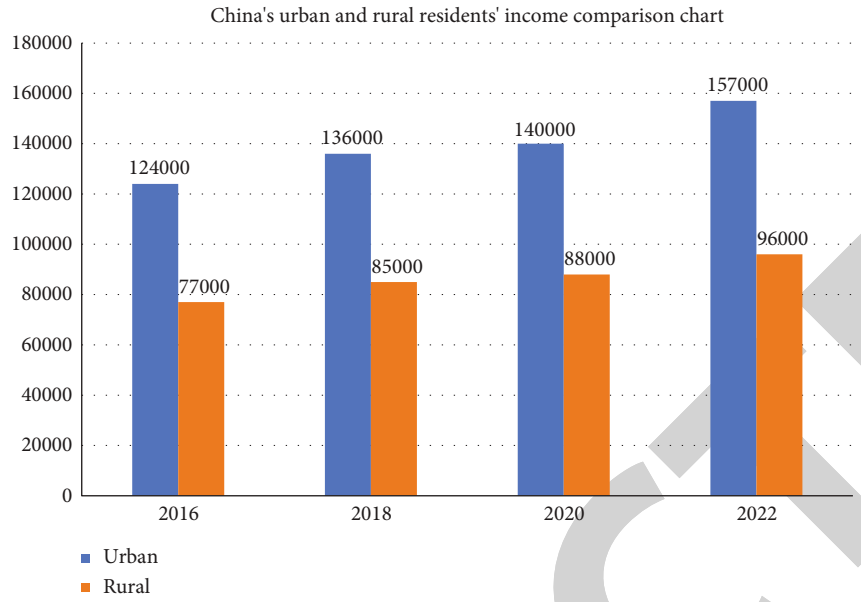

Figure 4: China's urban and rural residents' income year-by-year comparison chart.

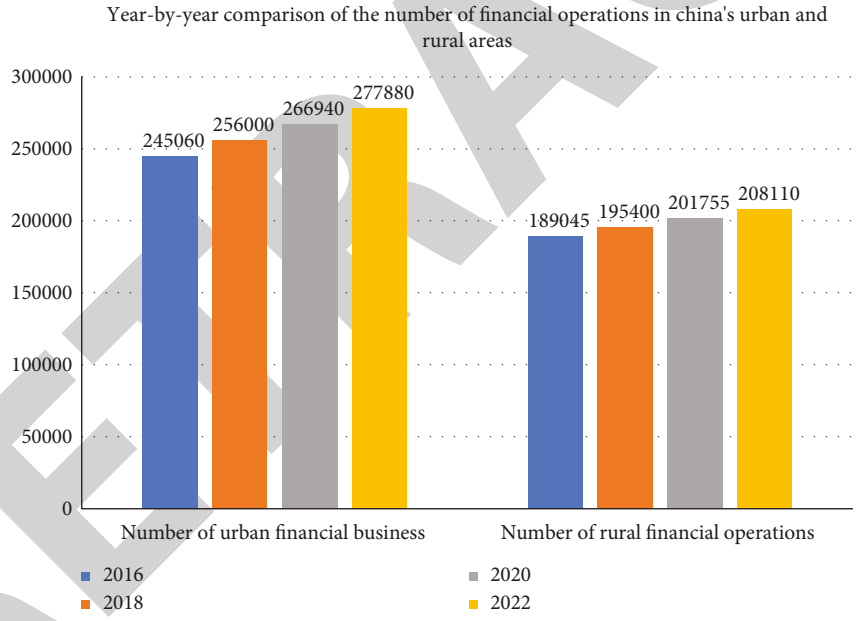

Figure 5: Comparison of the number of urban and rural business in China year by year.

ratios of operational risk, unskilled business process, lack of risk capability, and lack of monitoring system accounts for the proportion of financial institutions' operational risk comparison as follows: 32.64% for unskilled business process, 35.85% for lack of risk capability, and 31.51% for lack of monitoring system, thus proving that the three main causation ratios are balanced. The three factors are the same as the main factors that constitute the occurrence of operational risks in financial institutions, as shown in Figure 7

(5) Analysis of the impact of operational risk of financial institutions: the more the number of operational risk events, the greater the loss of financial institutions: the total number of risks of financial institutions in 2016 is 7000, and the loss of financial institutions is 155800; the total number of risks of financial institutions in 2018 is 8800, and the loss of financial institutions is 168120; the total number of risks of financial institutions in 2020 is 9000, and the loss of financial institutions is 180,440; in 2022, the total number of financial institution risks is 9,600 and the loss of financial institutions is 192,760; from the data analysis, it can be seen that the loss of financial institutions is proportional to the number of financial institutions' operational risk events, as shown in Figure 8

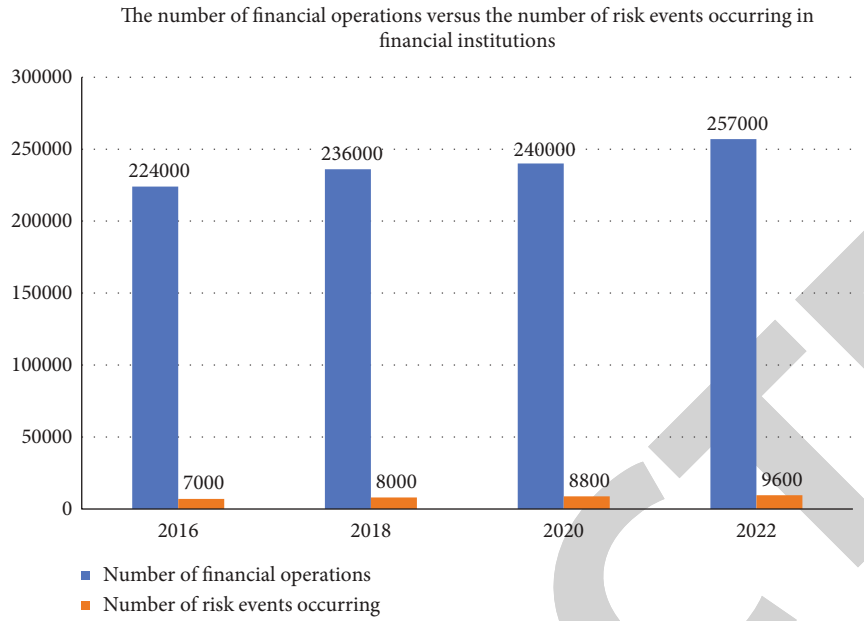

Figure 6: Year-by-year comparison of the number of financial operations and the number of risk events in financial institutions in China.

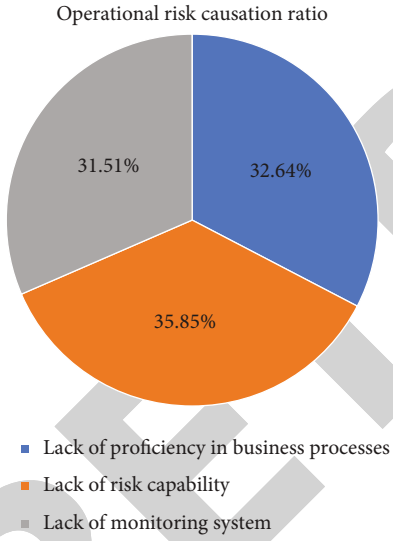

Figure 7: Analysis of the proportion of the three major causal factors of operational risk in financial institutions.

4.2. Analysis of Results. The above-mentioned points lead to the following result discussion: the causes and measures of operational risks of financial institutions are discussed in depth, respectively.

4.2.1. Causes of Operational Risks of Financial Institutions. The design of business processes and operations of financial institutions is not adapted to the business processes of financial institutions, which determines that financial institutions cannot have a good quality of work. Most of the accounting processes of financial institutions are designed to be operational, with overemphasis on risk control and lack of consideration of the feasibility of system implementation, resulting in rules and procedures that are incompatible with accounting operations, which affects the implementation of the system. Secondly, in the process of accounting operations, some loopholes exist in some business operations, and some business authorization operations are not standardized, which increases the possibility of operational risks. For example, when opening a personal account, the account holder must have a valid certificate, but some financial institutions can handle the process of opening an account by providing a copy of the situation, violating the terms of account opening and forming a hidden problem. In addition, the operation of financial institutions has become more difficult due to the renewal and upgrading of their business systems. With the emergence of new business products, operators are unable to conduct business training in a timely manner, which has an impact on business management and is detrimental to the development of financial institutions. Finally, the accounting system of some financial institutions cannot be updated in a timely manner, the scope of business is expanding, and the system process cannot adapt to the needs of risk prevention, which easily brings losses to financial institutions.

The accounting operation business process execution process is the performance of financial institutions' accounting operation business process specification. It can reduce the probability of operational risks, but most financial institutions have some problems in the process of accounting operations. First, the implementation of business process is not strictly supervised and some staffs miss the operation steps. The main reason is that staffs do not establish proper awareness of accounting operation business process and are not familiar with the operation steps, which can easily cause risky accidents. Secondly, some branches of financial institutions have lax work management, such as ignoring the illegal operation of cashiers and not conducting business review in time. In this case, the supervision is too lax and not strict enough, which is very likely

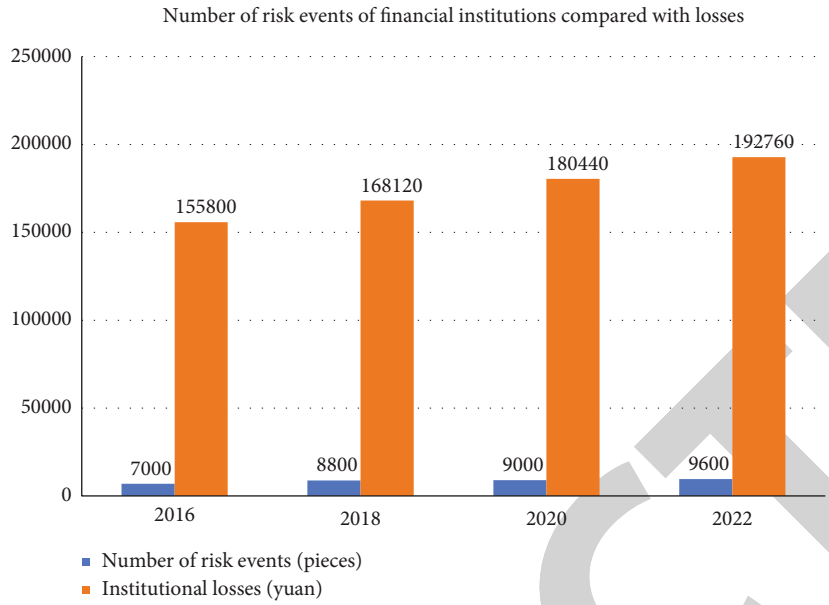

Figure 8: The number of financial institutions' operational risks versus losses.

to cause risky accidents and affect the quality of accounting operation risks of financial institutions. In addition, the internal accounting supervision of some financial institutions is too superficial and fails to deeply understand the importance of internal accounting supervision, which reduces the degree of preventing operational risks and leads to a loose process of implementing accounting operation business processes, making it difficult to achieve effective risk control.

At present, most financial institutions can control operational risks through a series of means such as authorization review, but with the lack of systematic prediction ability, there are still some loopholes. With the continuous improvement of information technology, if financial institutions cannot monitor the risk points of accounting business processes in real time through information technology, they cannot adapt to the needs of social development, lack risk warning capability, and rely too much on manual supervision, which increases the difficulty of operational risk control. For example, in the actual financial institution system, large transactions need to be authorized for processing, but some financial institutions do not follow the settings for authorization of cumulative transaction volume, so most cashiers violate the rules when processing large transactions by splitting them into small ones to avoid delegation of authority. Secondly, the accounting system of most financial institutions lacks the risk control capability to monitor and review all aspects of the business process in real time, resulting in failure to remedy risks in a timely manner, causing huge losses to the financial institutions and exposing them to greater risks.

Personnel management cannot adapt to the development of financial institutions in recent years, the business volume of financial institutions has been increasing, but the growth rate of financial institutions' personnel is small and uncoordinated, and most financial institutions lack sufficient accounting business personnel, mainly due to cost savings and personnel transfer, and face serious personnel mobility challenges, insufficient level of human resource management, and no humane management ideas, so it is extremely easy to cause accounting business risks. In addition, the structure of accounting business personnel in financial institutions is not reasonable. At present, most of the staff structure tends to be young, with strong ability to learn and handle knowledge and innovative thinking, but young employees lack certain work experience and have the ability to choose their career due to the advantage of age, and financial institutions attach less importance to their work, so the level of staff management is low and has not been improved. Finally, cashiers in financial institutions also lack sufficient training and certain risk awareness, resulting in errors that cannot be dealt with in a timely manner and a lower standard of operating process, thus increasing the possibility of risks.

With the increasing competition in the market, financial institutions are paying more and more attention to the evaluation of marketing indicators such as loans in order to improve their competitiveness. In recent years, the difficulty of marketing indicator tasks has gradually increased and the evaluation model is relatively simple, which tends to cause a certain amount of evaluation pressure. Most of the employees will form the one-sided thinking of "emphasizing business development and neglecting risk control", emphasizing business development and lacking awareness of accounting system, which will accumulate various business risks of financial institutions in the long run and is not conducive to the stable development of financial institutions. In addition, the lack of sufficient communication and feedback between accounting staff and accounting managers makes it difficult to balance the standardized operation of accounting business with the flexibility of market demand, leading to the contradiction between risk control and business development and affecting the effectiveness of risk management.

4.2.2. Risk Measures for Financial Institutions' Operations. The standardization of accounting operation business processes in financial institutions is an important factor leading to operational risks, so the standardization of accounting operation processes must be strictly controlled. First of all, financial institutions should improve the accounting operation business process system, improve the adaptability of business processes and operations, distinguish different operations as the scope of business expands and the volume of business increases, establish management mechanisms for various operations such as parameters, information maintenance, and data, improve the standardization of business operations, and appropriately establish risk analysis systems and major event reporting systems, according to the actual situation of financial institutions themselves. Make the operators participate in the process of system development, so that the business process design of accounting operations can be more in line with the front office operations and effectively prevent risks. Secondly, financial institutions should strengthen the standardization of accounting business operating environment, divide business types according to business requirements, improve the accuracy of business operations, raise the system awareness of accounting practitioners, standardize employee behavior, strengthen risk management education, establish reward and punishment systems, clarify responsibilities, and realize effective process control. Finally, in order to solve the system update problem, financial institutions should explain the new business before the system update so that employees can quickly understand the business, avoid mistakes, and improve the service level of financial institutions.

Since accounting operations run through the whole process of financial institutions' operations, improving the level of supervision and control of accounting operations business processes can effectively improve the risk management capability of financial institutions. Firstly, the business operation and supervision capability should be strengthened so that employees strictly follow the business process, and if there are irregularities, they should be handled strictly in accordance with the regulations and consciously resist irregularities against employees and should be given appropriate incentives to strengthen employees' self-awareness of compliance with the regulations. Secondly, supervision should be strengthened to improve the ability of financial institutions to prevent risks, especially in terms of operating licenses, to enhance supervision, review the rationality of cashier business operations, and improve the level of supervision. In addition, financial institutions should strengthen internal inspection, identify and analyze the risks of accounting business operations, supervise business processes, improve the professional level of internal accounting supervisors, and ensure the effectiveness of internal inspection. Finally, financial institutions should establish a sound internal accounting inspection system, improve the binding force on accounting inspectors, clarify regulations, improve the strictness of supervision, and effectively reduce the occurrence of operational risk accidents.

In order to improve the efficiency of risk management, financial institutions should monitor the transaction behavior in real time, strengthen the improvement and consolidation of the early warning system, and combine typical prevention cases so that accounting operations can be carried out normally. First of all, the management should establish an early warning information management system and standardize all aspects of early warning information, and accounting institutions should establish a management mechanism for obtaining, analyzing, and feeding back information. Financial institution branches should also establish corresponding responsible person system, standardize operation details, strengthen prevention and control work and timely research and analysis to discover abnormal events, discover operation risks, develop measures to cope with nonabnormal events, eliminate early warnings in a timely manner, establish corresponding rectification mechanisms, and improve early warning operation risks of financial institutions. Secondly, financial institutions should strictly control the authorization of transaction links, realize effective process control, coordinate and unify the front and back office of financial institutions, seriously implement the tracking and feedback of early warning information, and improve the control level of accounting operation risks. Finally, financial institutions should establish a risk compensation mechanism to ensure that financial institutions minimize operational risk losses when they occur, in addition to predicting and controlling risks, so that financial institutions can carry out accounting operations smoothly.

Strengthening the rationality of personnel structure of accounting operations of financial institutions is the main body of accounting operations of financial institutions; therefore, the rationality of personnel structure and the rationality of personnel ability is the basis of risk management; therefore, it is necessary to further optimize the personnel structure and improve the quality and ability of personnel. First of all, financial institutions can recruit from abroad to ensure that financial institutions have sufficient reserves of accounting operation personnel, properly establish incentive mechanisms to improve the motivation of employees, solve the problem of the ratio of the number of employees to the number of operations in financial institutions, fully consider the ability and age of employees when determining the duties of positions, assign appropriate work according to their actual situation, improve the awareness of people-oriented management in financial institutions, and care and respect for employees so that they can develop their own values, improve their efficiency, and enhance their risk control capabilities. Secondly, with the development of business, the existing knowledge structure of accounting practitioners can no longer adapt to the development speed of financial institutions, so it is necessary to conduct relevant business training to improve the business ability of practitioners and ensure their accurate operation of new business. In addition, accountants should establish a sense of risk prevention and strengthen risk control by intercepting and identifying fraudulent acts of financial institutions. First of all, the management of financial institutions must help to improve risk awareness, focus on the construction of internal control, establish a perfect internal control system, improve the phenomenon of financial institutions' heavy

business, improve their management level, effectively reduce the possibility of various risks, center on business development, and ensure the normal implementation of internal control. Secondly, reeducation of employees should be strengthened to raise the level of their awareness of risk internal control, establish correct risk management ideas, implement risk management ideas in depth, make employees take responsibility for risk prevention, recognize the importance of internal control, discover risk points in time, and improve the effectiveness of risk management in accounting operations of financial institutions.

5. Conclusion

In the process of analyzing the business risks of financial institutions, this paper uses data extraction techniques in the data processing process to analyze the business risks of financial institutions through data extraction and CFPS analysis methods to analyze the development background of financial institutions, the causes of operational risks, and measures to explore. The following conclusions are drawn.

The main causes of operational risks of financial institutions are as follows: the design of business processes and operations of financial institutions not adapting to the business processes of financial institutions, the specification of accounting operations business processes of financial institutions, the lack of systematic forecasting capabilities, the failure of personnel management to adapt to the development of financial institutions in recent years, and the existence of conflicts between risk control and business development.

The measures to solve the operational risks of financial institutions are as follows: standardization of operational business processes, improvement of the level of supervision and control of operational business processes, improvement of the efficiency of risk management, and rationalization of personnel structure and personnel capacity.

To sum up, financial institutions must improve their competitiveness and management level in order to stand firmly in the market. In order to improve the risk management of accounting business of financial institutions, they should standardize accounting business, improve supervision and control, ensure accurate business processes, strengthen early warning systems, enhance risk control capabilities, train and retrain employees, strengthen internal controls, balance risk management and business development, and promote the regulatory development of financial institutions.

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Research Article

Study on Impact Test System of Manipulator Based on Six Axis Force Sensor and Intelligent Controller

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With the development and application of intelligent nervous system, intelligent control system represented by machine vision has been promoted and used in various fields, including manipulator control system. Mechanical arm is the main actuator of robot and other mechanical components, but the application environment of mechanical arm is extremely complex, and with the development of industrial process, the sensitivity of technology and operating system for its arbitrary posture operation is also steadily improved. Based on the above problems, this paper designs a manipulator control system based on machine vision theory and orthogonal parallel six-dimensional force sensor to meet the working requirements of manipulator in high-precision environment. Systems hardware are consisted by machine vision structure and six dimensions of force sensor. The practical application effect of the model was verified by collision detection experiment. The relevant research can provide theoretical guidance and practical reference for the research of manipulator control field. Dance and practical application reference for the research of manipulator control field.

1. Introduction

The control of manipulator has always been an important and hot issue in mechanical control. At present, the control theory and method of manipulator have been deeply studied [1–3]. Machine vision technology takes the photosensitive element as the processing core and uses the analog signal transmitted by the optical sensor to convert and collect the electrical signal and optical signal. With the development of camera and imaging processing technology, the data information processed by machine vision processing technology can be transformed from two-dimensional to three-dimensional. Under the influence of automatic machinery production mode, industrial manipulator has become an important equipment to support modern production. How to realize the automatic control process of industrial manipulator has also become a current research hotspot.

The early vision-based manipulator control system is to process the image and obtain the target position from the image, so as to achieve the effect of intelligent control and closed-loop control [4, 5]. For example, Li y et al. used the closed-loop vision algorithm developed based on monocular and binocular vision to realize the step of pose estimation from target recognition, which is completely automatic [6–8]. However, the manipulator control system relying only on vision cannot meet the needs of modern industry because of its limited accuracy, the resulting error is also large, and the prior knowledge of the environment is required [9]. Literature [10] developed the controller of the manipulator based on the behavior data of the double rotating joint manipulator and the reinforcement learning algorithm, but there are some defects, such as limited data points and the need to configure a large amount of prior knowledge for the manipulator model, so it is impossible to control the manipulator with different structures after training one controller. The visual sensor can collect rich information in the image. By combining with the reinforcement learning algorithm, the intelligent controller can learn information from

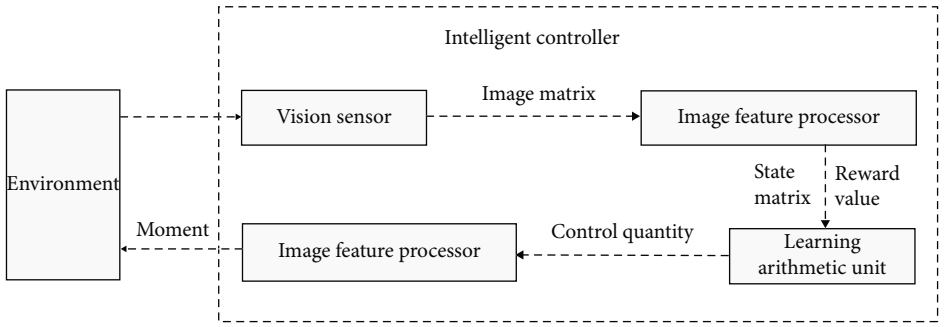


Figure 1: Intelligent control structure.

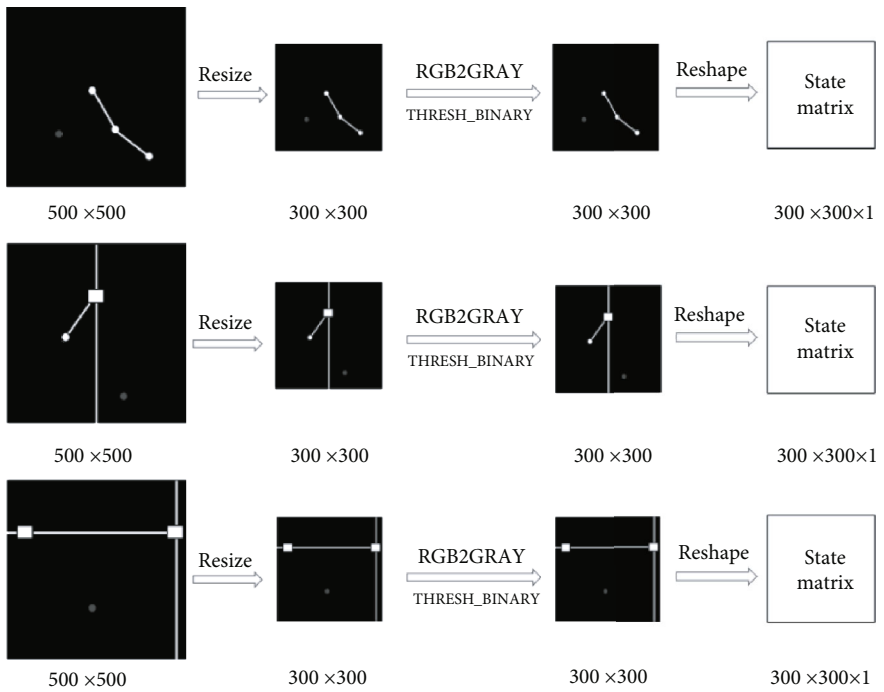


Figure 2: State matrix.

Table 1: Detailed parameters of camera.

Index	Camera parameters
Camera model	MindVision MV-U300
Effective pixel	2048H × 1536 V (3,000,000)
Pixel size	3.2 μm × 3.2 μm
Signal to noise ratio	43 dB
Optics	1/2"CMOS color
Data interface	USB2.0 480 Mb/s
Transmission distance	5 m
Power supply mode	USB power supply

the image independently, and the control strategy is optimized by the reward and punishment mechanism to realize the manipulator control after the manipulator with different structures is trained by the intelligent controller without any prior knowledge of the manipulator structure model [10–12].

The above shows that the use of machine learning combined manipulator alone cannot meet the high-precision requirements of today's manipulator [13]. Therefore, many scholars turn their research objectives to the six-dimensional force sensor with high-precision performance. The core technology of the development of the six-dimensional force sensor is the structural design of the sensor elastomer, and its structural form directly affects the performance of the six-dimensional force sensor [14]. With the development of robot application towards high speed and high precision, the problem of dynamic force measurement is becoming more and more prominent. The six-dimensional force sensor not only requires high sensitivity and small cross interference in each axis, but also requires a certain working bandwidth to meet the needs of dynamic force measurement. In order to adapt to different working environments, the structures of six-dimensional force sensor elastomers developed by experts and scholars are also diverse. Among them, Korean scholars have designed a

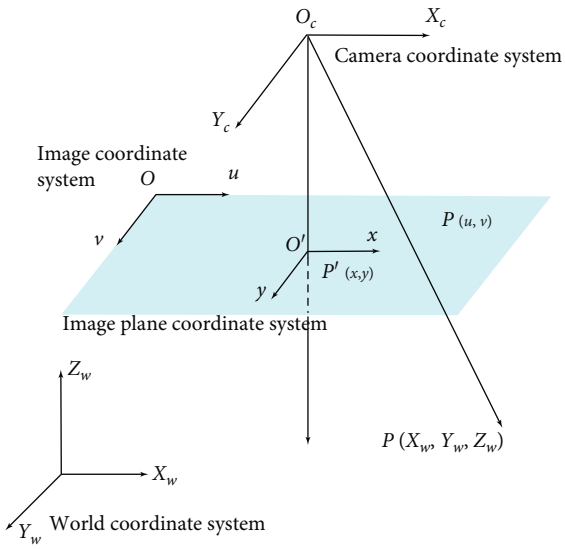


Figure 3: Perspective projection model of camera.

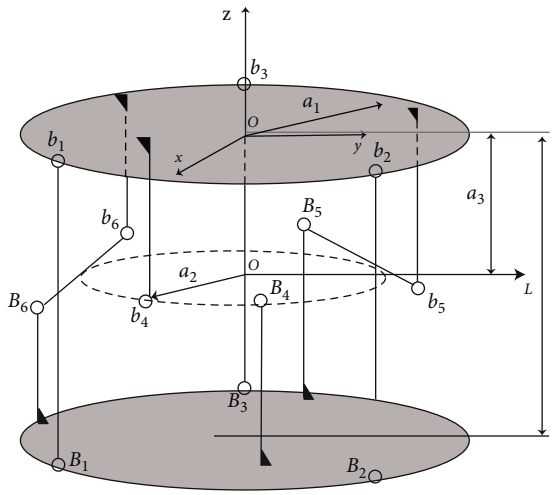


Figure 4: Structural diagram of orthogonal parallel six-dimensional force sensor.

six-dimensional force/torque sensor to detect the full force information of the foot of humanoid robot. The sensor is small and has adjustable and independent sensitivity to different force components [15, 16]. Ge Yu of the Institute of intelligent machinery, Chinese Academy of Sciences, and others invented an ultrathin six-dimensional force/torque sensor based on cross beam and double E-shaped film, which is used to obtain force sensing information of underwater robot wrist [17–19]. In addition, because the cross beam sensor has the advantages of symmetrical structure, high sensitivity, and small-dimensional coupling, more and more scholars improve it in order to obtain a six-dimensional force sensor with better performance [20–22]. The sensor has the characteristics of high sensitivity and small-dimensional coupling. Based on the traditional cross beam sensor, Wu C et al. [23–25] proposed a new six axis wrist force sensor by setting through holes on each sensitive beam. The sensor has good static and dynamic characteristics.

To sum up, machine vision can better meet the intelligent recognition requirements of the manipulator system, while the six-dimensional force sensor can better meet the sensitivity and accuracy requirements of the manipulator in the manipulation process. Therefore, this paper applies machine vision and six-dimensional force sensor to the manipulator control system with high accuracy requirements, in order to realize the use requirements of the manipulator control system in the environment with high intelligence and high accuracy requirements.

2. Basic Theory

2.1. Design of Controller. In order to realize the autonomous control of the manipulator, an intelligent controller based on machine control is designed. By learning step by step, the intelligent controller finally learns to control the movement of the manipulator, so that the end of the manipulator is controlled from the initial position to the target position. In each step, the intelligent controller collects the image of the environment through the visual sensor and obtains the next control quantity through online learning.

As shown in Figure 1, the intelligent controller includes a vision sensor, an image feature processor, a control actuator, and a learning arithmetic unit.

2.1.1. Vision Sensor. The visual sensor collects the actual information of the current environment in the form of color image, and the image matrix is the three-dimensional image matrix of RGB mode. The image matrix contains the current state and target state of the manipulator, as well as environmental information.

2.1.2. Image Feature Processor. After graying and thresholding the received image matrix I, the image feature processor adjusts the size and deformation and then outputs the state matrix s_t to the core of the reinforcement learning algorithm. Figure 2 describes in detail the process of rr types of manipulator, xr types of manipulator, and xy types of manipulator acquiring image matrix I by visual sensor and inputting it to image feature processor for processing into state matrix s_t.

2.1.3. Control Actuator. The reinforcement learning algorithm operator generates a control amount $a_t(a_1, a_2)$ according to the state matrix s_t and reward value r_t generated by the image feature processor. The control actuator calculates the feed increment required to control the rotating joint or slider of the manipulator through the control amount a_t and then maps the rotation angle increment directly to the joint torque $M_t(m_1, m_2)$.

$$r_t = \sqrt{(x_1 - x_2)^2 - (y_1 - y_2)^2}, \tag{1}$$

where x_i and y_i represent the coordinate position of the manipulator control system.

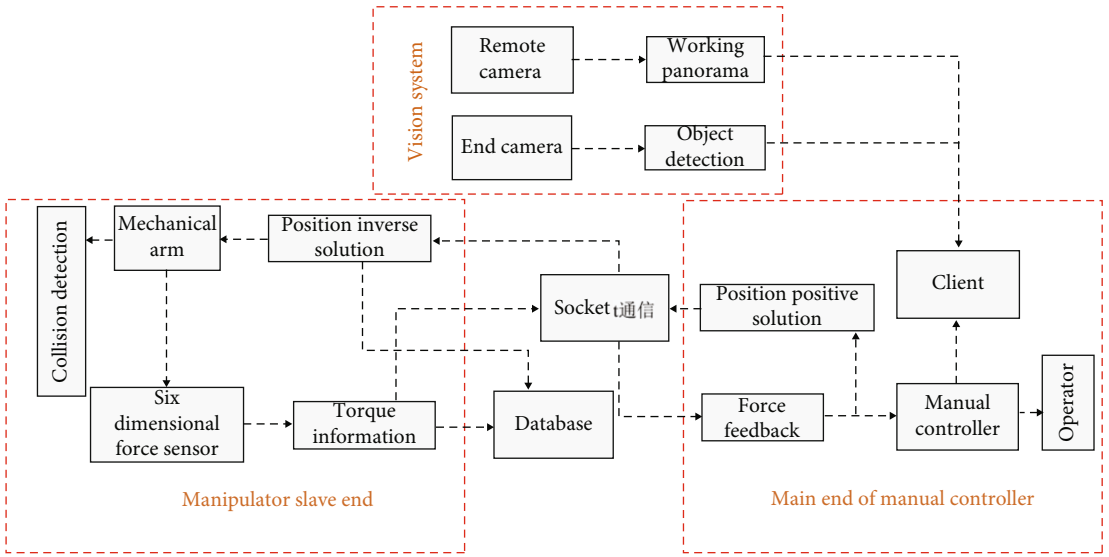


Figure 5: Design diagram of collision detection system.

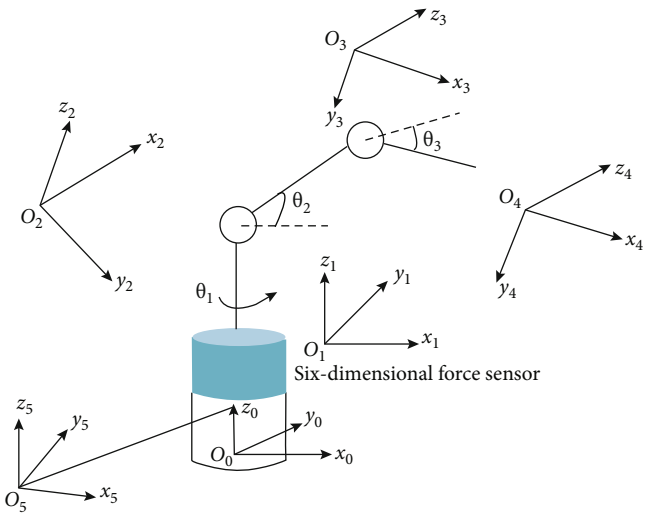


Figure 6: Schematic diagram of sensor installation position.

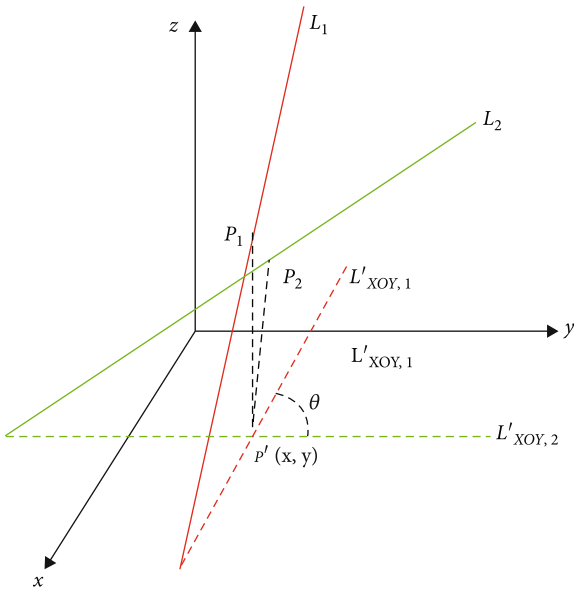


Figure 7: Schematic of projection method.

2.1.4. Learning Arithmetic Unit. The learning arithmetic unit calculates the state matrix and reward value transmitted by the current image feature sensor, generates the control quantity, and inputs it into the manipulator through the control actuator, resulting in changes in the environment.

According to Equation (1), the principle in learning is that if the learning process deteriorates, the distance between the end position of the manipulator and the target position increases, and the reward value is reduced to punish. If the learning process is improved, the distance between the end position of the manipulator and the target position decreases, and the reward is carried out by increasing the reward value.

2.2. Machine Vision Learning Model

2.2.1. Camera Selection. When the industrial manipulator completes its work, it needs to obtain the visual information in the environment and locate the workpiece position or target position. Therefore, it is necessary to map the position information in the image to the real-world coordinate system, so it is necessary to calibrate the camera and establish the relationship between the coordinate systems.

When collecting information, we generally need to select an appropriate camera to collect the required information. The vision system in this paper is mainly composed of two cameras. The remote camera is fixed in front of the manipulator to shoot the target point, and the end camera is fixed at the end of the manipulator to form a hand eye system, which is used to complete the tasks of defect detection and so on. Therefore, the camera needs to have appropriate focal length, good definition, and resolution. The detailed parameters of the camera are shown in Table 1.

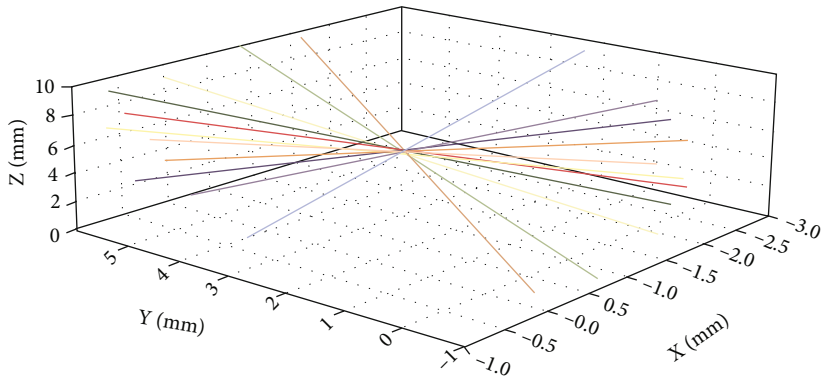


Figure 8: Schematic diagram of external force vector line.

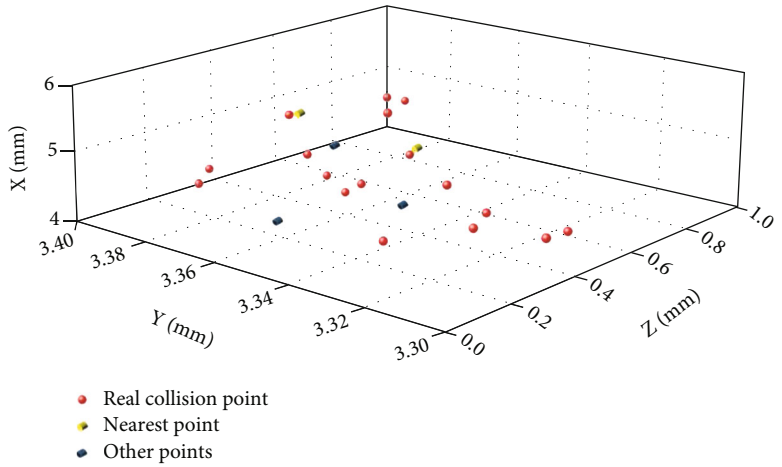


Figure 9: Optimal search results.

2.2.2. Camera Calibration. The process of camera calibration is to determine the projection matrix P converted from the world coordinate system to the image coordinate system. Camera calibration is generally divided into two parts. One is to convert from the world coordinate system to the camera coordinate system. In this step, the camera external parameters R, T (rotation matrix, translation matrix) and other parameters are determined. The second part is to convert from the camera coordinate system to the image coordinate system. In this step, the camera internal parameters K and other parameters are determined. The camera imaging model is divided into linear model and nonlinear model. The perspective projection model of the camera is shown in Figure 3 without considering the lens distortion.

The perspective projection model contains four coordinate systems. World coordinate system $O_w - X_w Y_w Z_w$, that is, a real coordinate system defined by the user in the real space according to the needs, reflecting the actual spatial position of the camera and the measured object. The camera coordinate system 2, its origin is the optical center of the camera, and the z-axis coincides with the camera optical axis, and the X_c axis and Y_c axis are parallel to the xy axis of the imaging plane coordinate system. It is defined to describe the object position from the perspective of the camera. Like the plane coordinate system o' – xy, this coordinate system is the plane imaged by the photosensitive element of the camera and is the coordinate system obtained by translating the camera focal length f distance along the z-axis of the camera coordinate system. Image coordinate system, that is, the coordinate system o – uv of the image we see. The origin is in the upper left corner of the image, and the unit is pixel. The optical signal collected by the camera through the sensor is converted into digital signal, that is, the image we see. An image can be regarded as a matrix of $M \times N$, and each value in the matrix is the gray value of each pixel.

3. Six-Dimensional Force Sensor Model

In the manipulator control system, the dynamic performance of the force sensor directly affects the practical application performance of the manipulator. Force sensor is a kind of electrical component that converts force signal into relevant electrical signal. Among them, the six-dimensional force sensor can measure the force and torque information about the three coordinate axis in space at the same time. It is the most complete form of force sensor.

3.1. Orthogonal Parallel Six-Dimensional Force Sensor Model. The orthogonal parallel six-dimensional force sensor

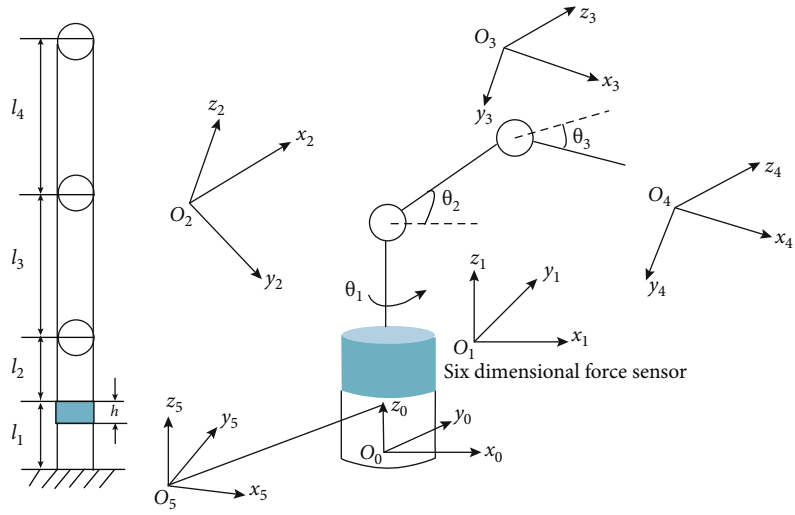


Figure 10: Structure of manipulator.

Table 2: Member parameters.

Connecting rod serial number	Quality	Relative position of centroid/ mm
0	1.598	(0, 0, 60)
One	1.686	(0, 0.7, 0.24)
Two	2.489	(84.685, 0, 0)
Three	3.201	104.684, 0, 0

is composed of three parts: force measuring platform, fixed platform, and force measuring branch. The structure of the force measuring platform is exactly the same as that of the fixed platform. Each platform contains three support columns, which are distributed symmetrically around the z -axis of the coordinate system. There are six force measuring branches in total, which are S-type single-dimensional force sensors, and the middle part is fixed with a strain gauge for detecting the axial force on the force measuring branch. Among the six force measuring branches, three force measuring branches are placed vertically and connected with the two platforms. The three force measuring branches are placed horizontally and connected with the respective supporting columns of the two platforms. The connection methods are all elastic spherical joints, and the three vertical force measuring branches and three horizontal force measuring branches are also circumferentially symmetrical about the z-axis of the coordinate system.

Because the force measuring branch and the two platforms are connected by elastic spherical joints, ideally, the force measuring branch can be regarded as a two force element and only bear its own axial tensile pressure. Moreover, because the vertical force measuring branch and the horizontal force measuring branch are arranged orthogonally in the space, when the force received by the six-dimensional force sensor is the force in the x, y direction and the torque in the z direction, the force measuring branch mainly measured is the force measuring branch arranged horizontally. When the applied force is the moment in x, y direction and the force in z direction, the main force measuring branch is the force measuring branch arranged vertically. This arrangement of force measuring branches makes the measurement of six-dimensional external force more accurate from the structural principle, and the interdimensional coupling of six-dimensional force sensor can be reduced.

3.2. Mathematical Model of Orthogonal Parallel Six-Dimensional Force Sensor. Figure 4 is the structural diagram of orthogonal parallel six-dimensional force sensor.

$b_1b_2b_3$ represents the force measuring platform, and $B_1B_2B_3$ represents the fixed platform. b_1B_1, B_2b_2, B_3b_3 is three force measuring branches arranged vertically, and the included angle between any two points of b_1, b_2, b_3 and the origin o is 120°. b_4B_4, b_5B_5, b_6B_6 is three horizontally arranged force measuring branches, their axes are tangent to a circle with a circle center of o', the three tangent points are the midpoint of the horizontal force measuring branch, and the included angle between any two tangent points and the origin o' is also 120°.

The rectangular coordinate system $o - xyz$ is the measurement reference coordinate system of the six-dimensional force sensor, and the origin o is determined as the geometric center of the lower surface of the force measuring platform, wherein, the x-axis is perpendicular to the horizontal force measuring branch b_4B_4, and the z-axis is perpendicular to the fixed platform $B_1B_2B_3$ and upward.

3.3. Vibration Model of Orthogonal Parallel Six-Dimensional Force Sensor. Taking the whole orthogonal parallel six-dimensional force sensor as the research object, when the force measuring platform is affected by the external force F_w, its spatial motion is described by the generalized coordinate $q = [q_1 q_2]^T = [q_x q_y q_z q_{mx} q_{my} q_{mz}]^T$, where $q_1 = [q_x q_y q_z]$ defines the movement of the force measuring platform about the three coordinate axis and $q_2 = [q_{mx} q_{my} q_{mz}]$ defines the

Table 3: Results of mechanical arm impact test.

Serial number	Detection force/N	Component force in three directions/N	Collision position/mm	Capacity of calculation/N	Calculation position/mm	Force absolute error/N	Relative error of force/%	Position absolute error/mm	Relative position error/%
1	100	-45.01	116.79	-46.36	122.10	1.35	0.88	5.31	4.83
		-62.86	69.72	-62.23	76.49	0.63	0.88	6.77	4.83
		63.41	298.71	64.45	302.47	1.03	0.88	3.76	4.83
2	100	62.35	0	60.38	1.35	1.97	2.38	1.35	1.78
		73.95	38.49	72.75	37.64	1.20	2.38	0.85	1.78
		25.38	167.03	24.31	167.90	1.07	2.38	0.87	1.78
3	100	72.19	213.41	70.71	226.90	1.48	0.58	13.41	7.78
		30.16	124.08	29.67	135.71	0.49	0.58	11.63	7.78
		-62.28	486.49	-63.28	503.80	0.99	0.58	17.31	7.78
4	100	76.9	64.07	78.76	261.18	1.81	0.76	2.65	2.85
		14.69	36.83	16.42	261.18	1.73	0.76	2.16	2.85
		-62.22	264.19	-61.65	261.18	0.56	0.76	3.01	2.85
5	100	92.68	40.03	94.56	40.46	2.26	2.20	0.43	1.55
		10.35	0	9.67	0.04	0.67	2.20	0.04	1.55
		36.08	148.03	37.55	149.93	1.47	2.20	1.90	1.55
6	100	-82.94	48.63	-84.19	47.32	1.25	1.95	0.49	2.39
		48.67	0	49.61	2.38	0.93	1.95	2.38	2.39
		-27.41	184.16	-29.05	85.84	1.64	1.95	1.68	2.39

rotation of the force measuring platform about the three coordinate axis.

The vibration model of the orthogonal parallel six-dimensional force sensor can be regarded as composed of six spatial single degree of freedom second-order mechanical vibration systems and one mass block M. The selection of the reference coordinate system $o - xyz$ of the whole system is the same as that in Figure 4.

Firstly, the relationship between the generalized coordinate q and the displacement l of the force measuring branch line is established. Based on the screw theory, then:

$$l_i = S_i \cdot (q_1 + q_2 \times r_i) = \left[S_i^T (r_i \times S_i)^T\right][q_1 q_2], \tag{2}$$

where S_i is the direction vector of the ith force measuring branch axis in the reference coordinate system $o - \mathrm{xyz}$ and r_i is the position vector of a point on the axis of the ith force measuring branch in the reference coordinate system $o - \mathrm{xyz}$.

4. Design of Manipulator Control System

4.1. Design of Collision Point Detection System for Manipulator Control. In order to test the feasibility of the application of the above six-dimensional force sensor model in the manipulator control system, this paper proposes a manipulator control system based on machine vision and six-dimensional force sensor. Different from the traditional application of six-dimensional force sensor, in order to realize the sensitivity of the manipulator control system, the collision detection method is used for the system design. The system design is shown in Figure 5.

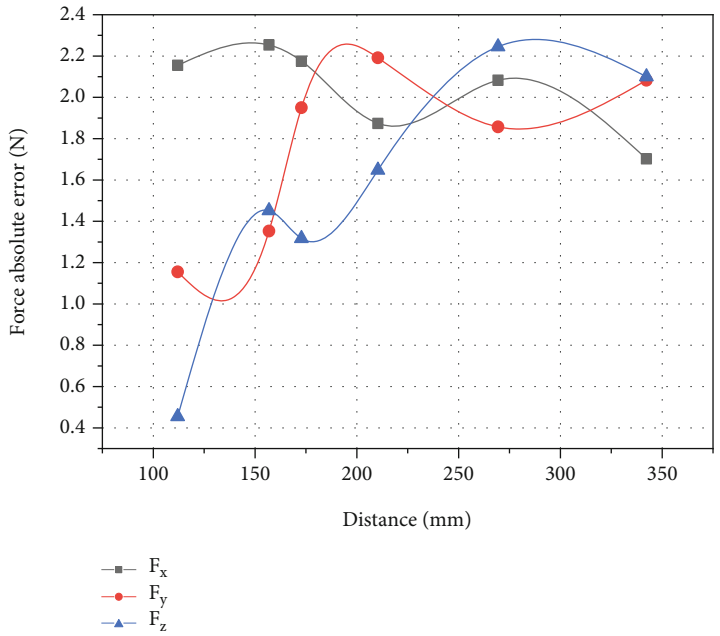
4.2. Collision Point Detection Model. According to the different impact points and external forces, body collision can be roughly divided into single point single external force collision, single point external force/external torque mixed collision, multipoint external force collision, and multipoint external force/external torque mixed collision. The collision of multipoint and multiexternal force/external torque can be regarded as a special combination of single point and single external force. In order to achieve high-precision collision detection, the installation position diagram of the sensor in this paper is shown in Figure 6.

The six-dimensional force sensor can measure the component information of force and torque on three axes. Assuming that the sensor at the base collects $F(F_x, F_y, F_z)$ and $M(M_x, M_y, M_z)$, the position information of the collision point is expressed as:

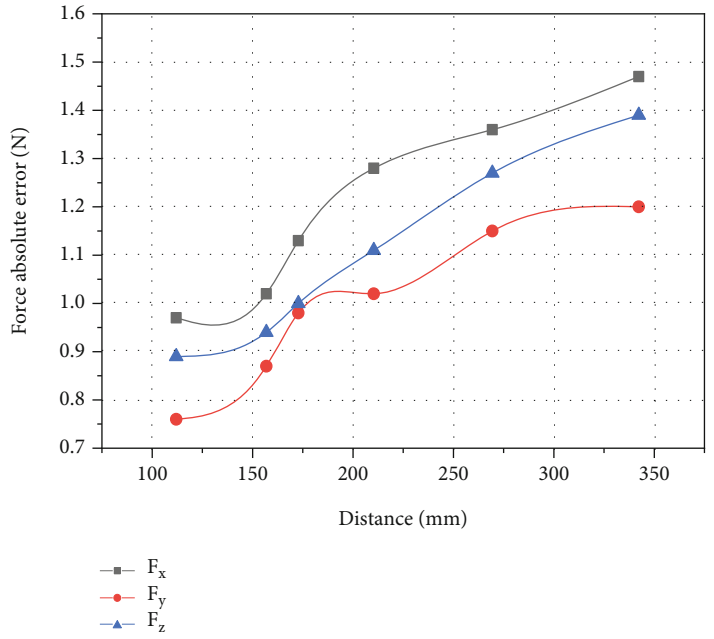
$$M = PF, \tag{3}$$

where $P(P_x, P_y, P_z)$ is the position vector of the collision point relative to the sensor coordinate system. Equation (3) can be rewritten as:

$$\begin{bmatrix} F_y & -F_x & 0 \\ 0 & F_z & -F_y \\ -F_z & 0 & F_x \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} M_x \\ M_y \\ M_z \end{bmatrix}. \tag{4}$$

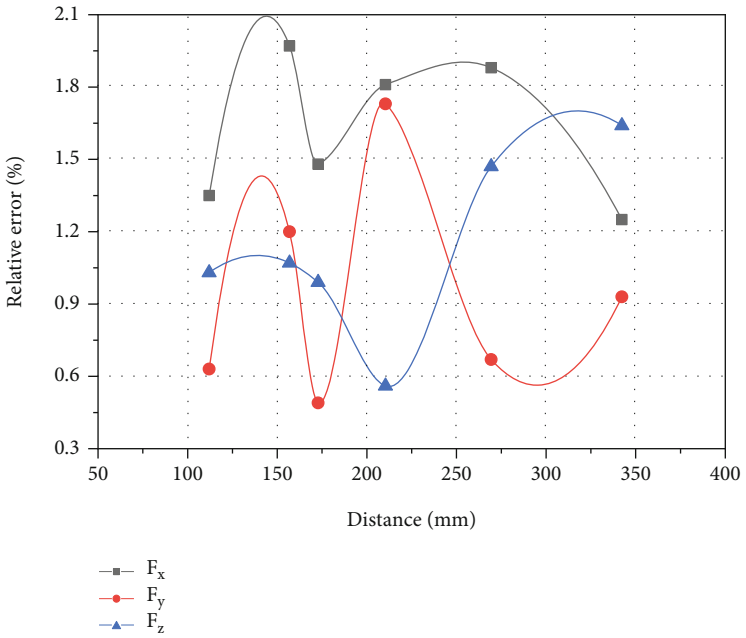


(a) Experimental result

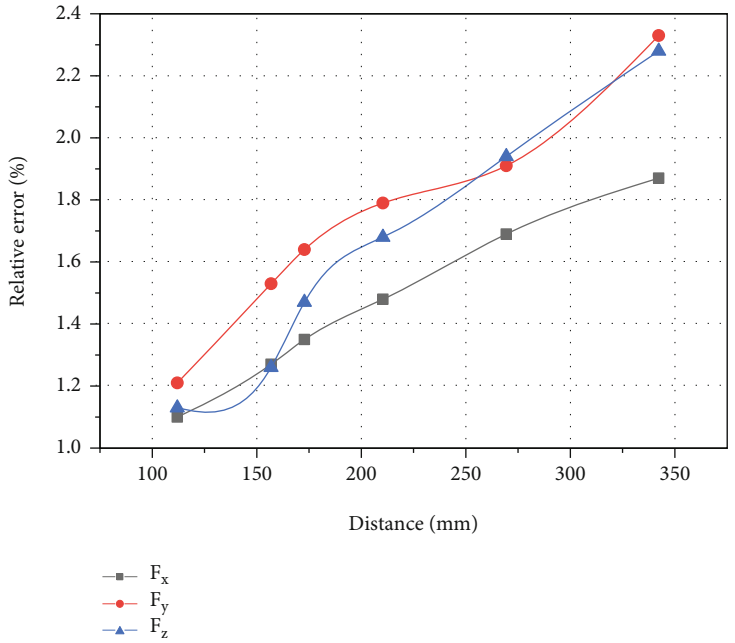


(b) Formula calculation results

Figure 11: Continued.



(c) Experimental result



(d) Formula calculation results

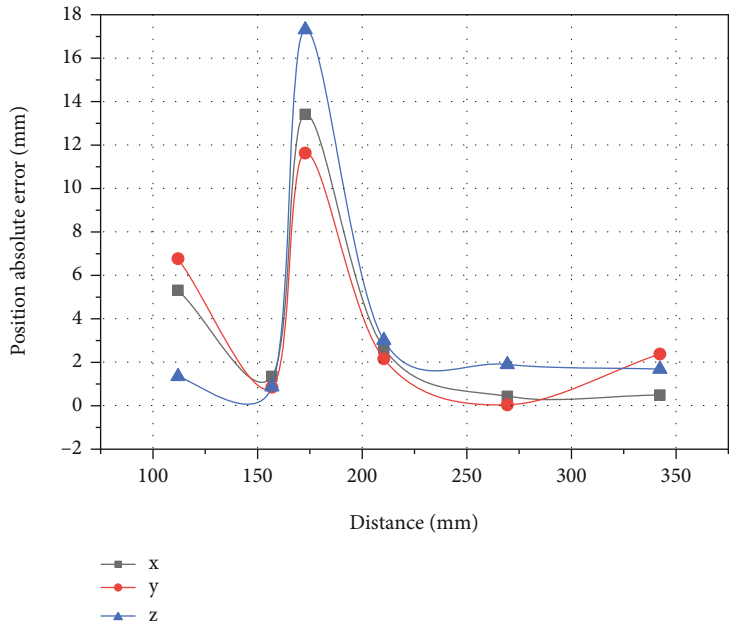
Figure 11: Comparison of calculation results (force error).

Because $|F| = 0$, the position solution of the collision point is not unique. At this time, other constraints need to be used to determine the position of the collision point. Substituting the data collected by the sensor to a frame into Equation (2) can obtain an external force action vector line $L_c(p)$, which is expressed as:

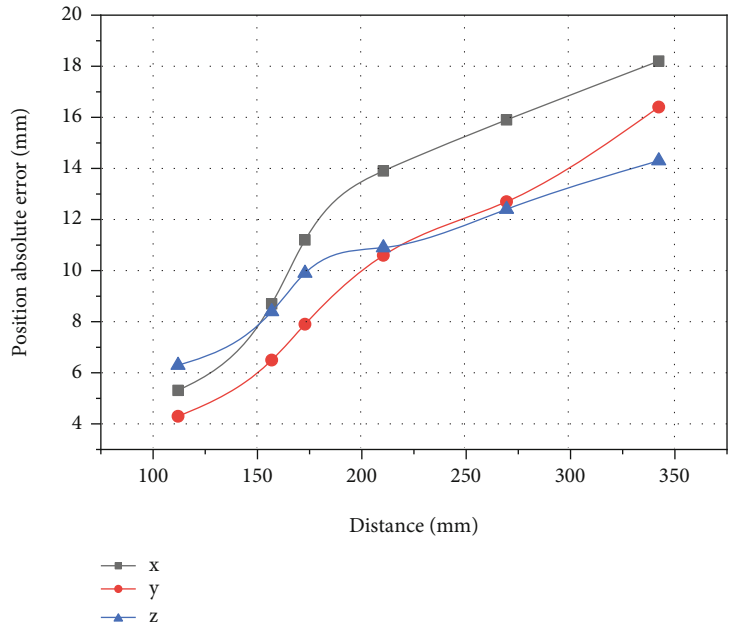
$$\frac{x}{F_x} = \frac{y + (M_z/F_x)}{F_y} = \frac{z + (M_y/F_x)}{F_z}. \quad (5)$$

Different parameters collected by each frame of the sensor determine different external force vector lines. In practice, most of the directions of the external force of the collision have a certain angle with the motion direction of the robot. Therefore, the external force vector lines calculated by using different frames of the sensor will intersect at a certain point P_c in space, which is the collision point. The specific calculation method is as follows:

$$\{P(x, y, z) | (x, y, z) \in L_{c1}(p) \cap L_{c2}(p)\}. \quad (6)$$

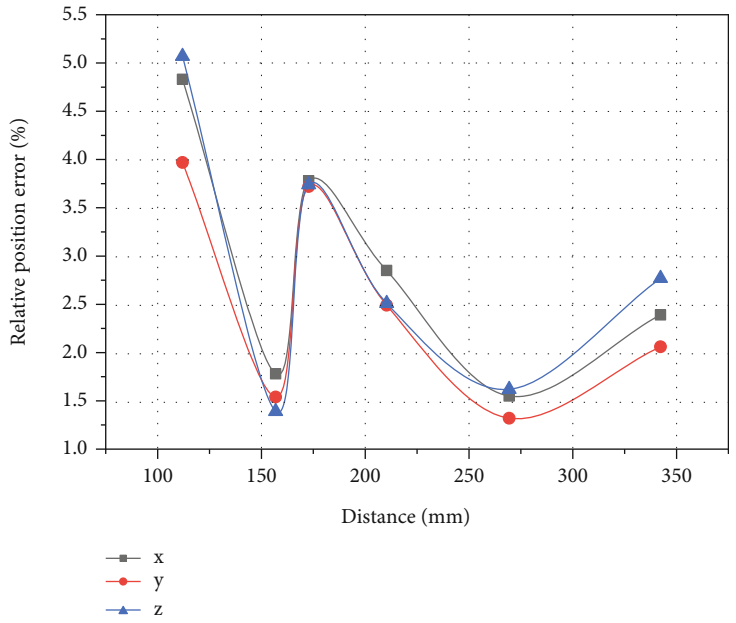


(a) Experimental result

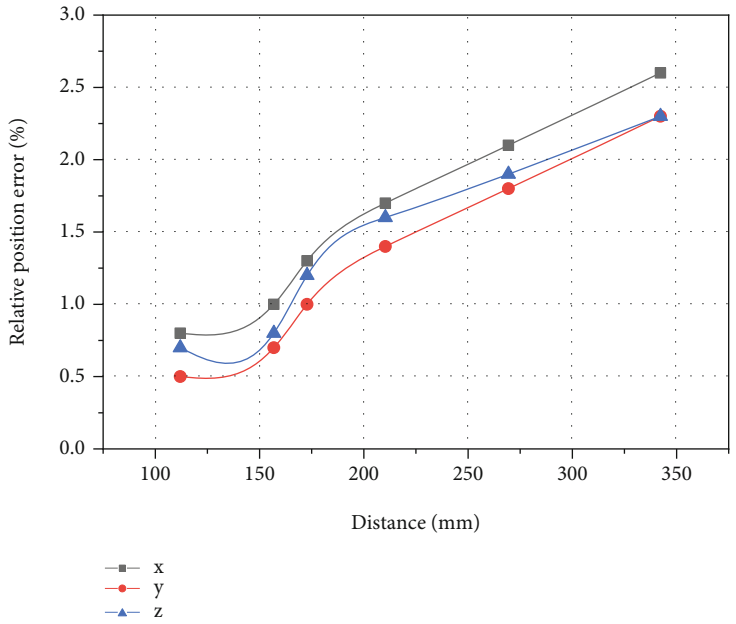


(b) Formula calculation results

Figure 12: Continued.



(c) Experimental result



(d) Formula calculation results

Figure 12: Formula calculation results (position error).

Due to the measurement error of the sensor, the calculated spatial force vector lines will not intersect at the collision point in space, but the projection in a certain plane will intersect near the projection of the formal collision point in the plane. Therefore, the intersection of the external force vector line in the plane can be obtained by the projection method, and then, the intersection coordinates can be substituted into the original equation to obtain the collision point information, as shown in Figure 7.

Suppose L'_{XOY} is the projection line of $L_c(p)$ in XOY plane, L'_{XOZ} in XOZ plane, and L'_{YOZ} in YOZ plane. The calculation formula is:

$$\begin{cases} F_y F_z x - F_x F_z y = -F_x M_x - F_y M_y \\ F_y F_z x - F_x F_y z = F_x M_x + F_z M_z \\ F_x F_z y - F_x F_y z = -F_y M_y - F_z M_z \end{cases}. \tag{7}$$

In Figure 7, $P'(x, y)$ is the intersection of the projection $L'_{\mathrm{XOY},1}$ and $L'_{\mathrm{XOY},2}$ of two external force vector lines, P_1 and P_2 are the corresponding points of the projection

intersection on the external force vector line, and the calculation formulas of P_1 and P_2 are:

$$P_n = \begin{cases} \eta L_1'\left(P'\right) \\ \eta L_2'\left(P'\right)(n=1,2) \\ L_{\mathrm{cn}}(p) \end{cases}, \tag{8}$$

where $\eta -_{\mathrm{is}}$ the selection factor for determining the best projection plane, and the selection rule of water projection plane is:

$$\max\left(\theta_{\mathrm{XOY}}, \theta_{\mathrm{XOZ}}, \theta_{\mathrm{YOZ}}\right) = \begin{cases} \theta_{\mathrm{XOY}}\left(L_n' = L_{\mathrm{XOY},n}'\right) \\ \theta_{\mathrm{XOZ}}\left(L_n' = L_{\mathrm{XOZ},n}'\right) \\ \theta_{\mathrm{YOZ}}\left(L_n' = L_{\mathrm{YOZ},n}'\right) \end{cases}, \tag{9}$$

$$\begin{cases} \theta_{XOY} = \left|\arctan\dfrac{F_{y1}}{F_{x1}} - \arctan\dfrac{F_{y2}}{F_{x2}}\right| \\ \theta_{XOZ} = \left|\arctan\dfrac{F_{z1}}{F_{x1}} - \arctan\dfrac{F_{z2}}{F_{x2}}\right| \\ \theta_{YOZ} = \left|\arctan\dfrac{F_{y1}}{F_{z1}} - \arctan\dfrac{F_{y2}}{F_{z2}}\right| \end{cases}, \tag{10}$$

where $\theta_{\mathrm{XOY}}, \theta_{\mathrm{XOZ}}, \theta_{\mathrm{YOZ}} -$ is the included angle of $L_{\mathrm{XOY},1}'$ and $L_{\mathrm{XOY},2}'$ projected by the external force vector line on the XOY, XOZ, YOZ plane.

If XOY plane is the optimal projection plane, the calculation formulas of $P_1(x_1, y_1, z_1)$ and $P_2(x_2, y_2, z_2)$ are:

$$\begin{bmatrix} F_{y1}F_{z1} & -F_{x1}F_{z1} & 0 \\ F_{y2}F_{z2} & -F_{x2}F_{z2} & 0 \\ -F_{z1} & 0 & -F_{x1} \end{bmatrix} \begin{bmatrix} x_1 \\ y_1 \\ z_1 \end{bmatrix} = \begin{bmatrix} -F_{x1}M_{x1} - F_{y1}M_{y1} \\ -F_{x2}M_{x2} - F_{y2}M_{y2} \\ M_{y1} \end{bmatrix}, \tag{11}$$

$$\begin{bmatrix} F_{y1}F_{z1} & -F_{x1}F_{z1} & 0 \\ F_{y2}F_{z2} & -F_{x2}F_{z2} & 0 \\ -F_{z2} & 0 & -F_{x2} \end{bmatrix} \begin{bmatrix} x_2 \\ y_2 \\ z_2 \end{bmatrix} = \begin{bmatrix} -F_{x1}M_{x1} - F_{y1}M_{y1} \\ -F_{x2}M_{x2} - F_{y2}M_{y2} \\ M_{y2} \end{bmatrix}. \tag{12}$$

The real collision point coordinates are near two points, but the exact position cannot be calculated. Therefore, it is preliminarily determined that the collision point P is the midpoint of two points, that is:

$$P = \frac{1}{2}(P_1 + P_2). \tag{13}$$

At the moment of robot collision, the sensor can collect multiple groups of data, and the schematic diagram of the solved spatial external force vector line is shown in Figure 8. In order to search the optimal solution closest to the real collision point in multiple groups of calculation results, it is assumed that $\zeta(\zeta_{M_x}, \zeta_{M_y}, \zeta_{M_z})$ is the error factor, and $P''(x'', y'', z'')$ is the preliminarily calculated collision point coordinate. Available:

$$\begin{cases} \zeta_{M_x} = F_z y'' - F_y z'' - M_x \\ \zeta_{M_y} = F_x z'' - F_z x'' - M_y \\ \zeta_{M_z} = F_y x'' - F_x y'' - M_z \end{cases}. \tag{14}$$

Among the preliminarily determined collision points, search the point that minimizes $|\zeta| = \sqrt{\zeta_{M_x}^2 + \zeta_{M_y}^2 + \zeta_{M_z}^2}$; that is, it is considered to be the optimal solution closest to the real collision point. The optimal search results are shown in Figure 9.

5. Simulation Experiment

In order to verify the effectiveness and accuracy of the collision point detection model proposed in this paper, a 3-DOF manipulator model is constructed for simulation experiments, as shown in Figure 10.

In order to reduce the amount of calculation, the connecting rod and joint center of the manipulator are symmetrical, and the center of gravity of each connecting rod is located on its own central axis.

Table 1 shows the structural parameters of each connecting rod of the 3-DOF robot in this paper. The material is alloy, $\rho = 2.7 \times 10^3 \mathrm{kg/m}^3$, In Figure 10, $l_1 = 120\mathrm{mm}$, $l_2 = 150\mathrm{mm}$, $l_3 = 200\mathrm{mm}$, $l_4 = 200\mathrm{mm}$, $h = 30\mathrm{mm}$. In Table 2, the member parameters are shown as follows.

The inertia tensor of each connecting rod relative to its center of mass is:

$$I_2 = \begin{bmatrix} 390.122 & 0 & -0.164 \\ 0 & 2.137 & 0 \\ -0.164 & 0 & 391.366 \end{bmatrix}, \tag{15}$$

$$I_3 = \begin{bmatrix} 402.110 & 515.403 & -89.144 \\ 515.403 & 700.313 & -66.861 \\ -89.144 & -66.861 & 1077.722 \end{bmatrix}, \tag{16}$$

$$I_4 = \begin{bmatrix} 123.919 & -292.363 & -103.181 \\ -192.163 & 809.897 & 37.927 \\ -103.181 & 37.927 & 905.914 \end{bmatrix}. \tag{17}$$

The data collected by the sensor at the base changes with time. After dynamic compensation processing, the data collected by the sensor is used as the input of Equation (4) to calculate the collision point. Import the manipulator model into Adams to verify the constructed manipulator model. In the experiment, the magnitude, direction, and position of the simulated impact force are known, and the

experimental result data are based on the sensor coordinate system.

In the experiment:$\theta_1 = -\pi/6$, $\theta_2 = -\pi/6$, $\theta_2 = -\pi/4$, $\dot{\theta}_1 = \dot{\theta}_2 = \dot{\theta}_3 = 0$, $\ddot{\theta}_1 = 0.3491\text{rad}/s^2$, $\ddot{\theta}_2 = 0.1746\text{rad}/s^2$, and $\ddot{\theta}_3 = 0.4363\text{rad}/s^2$. The robot moves repeatedly for 6 times according to the set parameters and carries out collision test at different points with the same collision force (100 N) when running to the third second. The experimental results are shown in Table 3.

In order to verify the accuracy of the proposed system, the error analysis of the experimental results is carried out.

$$\delta F = \frac{\Delta F_n}{|F_C|} \times 100\% (n = x, y, z), \tag{18}$$

where $\Delta F_n -$ is the absolute error of force in three directions and $|F_C| -$ is the modulus of measured force vector.

The calculation formula of relative error of resultant force is:

$$\Delta F_D = \frac{\left| \sqrt{f_{Cx}^2 + f_{Cy}^2 + f_{Cz}^2} - \sqrt{f_{Dx}^2 + f_{Dy}^2 + f_{Dz}^2} \right|}{\sqrt{f_{Cx}^2 + f_{Cy}^2 + f_{Cz}^2}} \times 100\%, \tag{19}$$

where $f_{Cx}, f_{Cy}, f_{Cz} -$ is the three directional components of the measured force and $f_{Dx}, f_{Dy}, f_{Dz} -$ is the three directional components of the calculated force.

The calculation formula of relative error in each direction of position is:

$$\delta P = \frac{\Delta P_n}{|P_C|} \times 100\% (n = x, y, z), \tag{20}$$

$$\Delta P_D = \frac{\Delta P_x + \Delta P_y + \Delta P_z}{\sqrt{P_{Cx}^2 + P_{Cy}^2 + P_{Cz}^2}} \times 100\%. \tag{21}$$

The calculation results are shown in Figures 11 and 12.

As shown in Figure 11, Figure 11(a) shows the error value of mechanical arm experimental resultant force, Figure 11(b) shows the error value of formula computer mechanical arm resultant force, Figure 11(c) shows the relative error value of mechanical arm experimental resultant force, and Figure 11(d) shows the relative error value of formula computer mechanical arm resultant force. Compared with Figures 11(a) and 11(b), it can be found that the fluctuation of mechanical arm resultant force experimental test value is significantly larger than that calculated by formula, and there is no obvious law. The difference between the maximum error value and the minimum error value is large, up to 2.26 N, and the minimum value is only 0.49 N. The change of the calculated value of the formula shows the law that it increases with the increase of the distance from the collision point, and reaches the maximum value at the farthest position from the force sensor coordinate system, which is close to 1.5 N. Comparing Figures 11(c) and 11(d), it is found that their performance rules are roughly the same as those in Figures 11(a) and 11(b). The difference is that in the relative error, the maximum values of the two are close, and the relative error of the measured value is less than the formula calculated value. Therefore, the formula calculation can reflect the relative error of the measured computer arm control system to some extent.

When the relative distance error of the mechanical arm (a) is the collision distance of the three points, as shown in the figure, the calculation error of the mechanical arm (b) is the relative distance between the collision points, and the calculation error of the mechanical arm (a) is the basic distance of the collision point, as shown in the formula of the collision point (b), and they are all within the allowable range of error. However, it changes with the distance of the collision point. The collision error first increases with the increase of the distance, and the maximum error is 16 mm, but the relative displacement error in all directions fluctuates in the range of about 5%. Compared with the formula calculation, the experimental error value is basically the same, and the farthest relative error is no more than 5%. It can be seen that this method can meet the collision accuracy requirements of the farthest point of the manipulator.

6. Conclusion

The sensitivity of the manipulator control system determines the process of industrialization. This paper proposes a manipulator control system based on machine vision and six-dimensional sensor, which can directly realize the intelligent and accurate control of the manipulator, solve the problem of low precision of the manipulator control system, and test the effectiveness of the system combined with the test of collision point. Through the actual measurement, inspection and analysis, the following conclusions are drawn:

(1) A manipulator control system based on machine vision and six-dimensional sensor is proposed. The manipulator visual servo structure in the system can effectively capture the target and transmit it to the six-dimensional force sensor to control the motion thread of the manipulator and guide the precise operation of the manipulator

(2) Through the simulation experiment of impact point, it is found that the manipulator control system constructed in this paper can effectively test the impact point. At the same time, the formula calculation shows that the accuracy of the manipulator control system will not change significantly with the change of the position of the impact point. It has high accuracy and small error, and the maximum error is not more than 5%, which meets the accuracy requirements of the detection of the impact point of the manipulator

Data Availability

The experimental data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Acknowledgments

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Retraction

Retracted: The Relationship between Body Mass Index and Physical Activity Participation Rate Design Based on Fuzzy Breakpoint Regression Design

Journal of Sensors

Received 23 January 2024; Accepted 23 January 2024; Published 24 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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Research Article

The Relationship between Body Mass Index and Physical Activity Participation Rate Design Based on Fuzzy Breakpoint Regression Design

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Obesity is a global public health problem in modern society. Body mass index (BMI) can measure whether a person's body is in obesity and health. Body mass is the quality of human body, which is a comprehensive and relatively stable characteristic of human body structure, physiological function, and psychological factors, and body mass is the basis of heredity and acquisition. Physical exercise is a kind of physical activity that people do in their spare time in order to exercise their body and mind. In this paper, we take the physical health problem of obesity as the background and combine the fuzzy breakpoint regression method to design the body mass index and physical exercise participation rate. The relationship between the body mass index and physical exercise participation rate design based on fuzzy breakpoint regression in this paper is mainly discussed as follows: background: the obesity rate is rising and chronic diseases caused by obesity affect health; results: jumps were observed for body health indices above 24.9 kg/m^2, while participation rates in physical activity decreased compared to the normal weight range; and conclusion: the greater the weight of the group, the less willingness to participate in physical activity and the lower the rate of participation in physical activity.

1. Introduction

Obesity is a global public health problem in modern society [1]. Body mass is the quality of the body. It is the property of complexity and relative stability of human structure, physiological functions, and psychological factors that underlie inheritance and acquisition. The American Academy of Sports Medicine (AASM) defines physical fitness as "the ability of an individual to participate in leisure-related activities without excessive fatigue, and to cope with unexpected events and perform daily tasks." Scientists currently classify the body as healthy (including cardiorespiratory fitness, muscular endurance, and body composition), physical (including sensitivity, balance, harmony, speed, flexibility, and responsiveness), and physiological (including morphological and structural integrity, metabolic function, and bone health). It follows that the body is a factor that is closely related to the level of physical activity and/or exercise capacity, which can be integrated in exercise to reflect and assess all structures and functions of the body, including oxygen capacity, strength and endurance, joint flexibility, exercise speed, sensitivity, coordination, and balance. Thus, the body includes the skeleton, body composition, cardiorespiratory function, circulation, endocrine, metabolism, nervous system, motivation, psychology, and nutrition. A strong organism implies that all these functions are well coordinated and adapted; weakness reflects multifunctional decline or abnormality in one or more parts of the body. Modern epidemiological studies focus on physical substances related to health, including oxygen (reflex functions) and muscles (participation in activities, daily activities, and disease prevention). Oxygen capacity tests, also known as maximum oxygen content tests, are commonly used to determine 20-meter concentricity, runner's tests, and motorcycle tests, and

traditional muscle tests include grip strength (upper body strength) and vertical jump (lower body strength). BMI measures whether the body is obese and healthy. Obesity has a huge impact on people, especially during childhood and adolescence. Obesity is strongly associated with adult obesity and cardiovascular disease. Numerous cross-sectional and vertical studies have shown that physical activity (especially high physical activity) and physical health (especially oxygen and muscle) in children and adolescents have a negative impact on future obesity. Therefore, an effective means of preventing obesity in the future is to expand physical activity, especially high-intensity physical activity, and to improve the physical fitness of children and adolescents. Life is running. Each of us is always exercising, but the form of exercise is just different, and we have a common goal, which is "exercise to strengthen the body." In this regard, physical activity is inevitably linked to physical fitness. Physical exercise can certainly make a person's physical strength. There are many factors that contribute to a person's physical fitness, such as genetics, nutrition, and lifestyle habits, but physical exercise is certainly one of the very important aspects. People who are naturally weak can strengthen their physique through physical exercise. Those who are physically fit will become weak due to lack of nutrition or poor lifestyle habits. It can be seen that physical exercise is only a necessary condition to enhance physical fitness, and although it plays a very important role, it cannot play a decisive role. In order to better explain the relationship between the two, we carefully explore the influence from both rational understanding and physical exercise. Physical exercise is a kind of physical activity that people do in their spare time in order to exercise their body and mind. The results show that participation in physical exercise not only directly improves people's physical performance during study but also improves their overall physical performance by improving exercise habits, which helps to reduce obesity and lower the risk of cardiovascular disease. Breakpoint regression is an empirical method based on randomized experiments only. It effectively uses real-world limitations to analyze the causal relationships between variables. In breakpoint regression, if the variable is greater than a threshold, the variable is processed; if the variable is less than a threshold, it is not processed. In general, the processed data cannot be directly observed. In breakpoint regression, people who did not reach the threshold can serve as a good control group to reflect what happened in the data processing, especially when the variables are continuous, and the difference between the threshold and the sample can appropriately reflect the relationship between sales and economic variables [2]. Breakpoint regression can be divided into two categories. The threshold is determined in the first category, that is, the threshold determined in the first category. All observations come from one side of the threshold, not all observations from the other side. In this case, the probability of removal from one side of the threshold shifts to the other. In the second case, the critical point is ambiguous; i.e., other matters in some cases, it is proved that regardless of the breakpoint regression method, the systematic change sampled near the threshold can be used to study the relationship between the removal of predictions and other economic variables. Breakpoint regression has many incomparable advantages: fast data processing speed and clear analysis structure. Therefore, fuzzy breakpoint regression of the relationship between BMI and physical exercise participation rate design has great advantages.

2. Research Background

Through reading and summarizing the literature, the research of fuzzy breakpoint and body weight exercise has made a lot of achievements, but few or even none of the studies combine the two aspects, so the starting point of this paper is very novel and unique. The following are the literature reviews.

2.1. Research Review of Breakpoint Regression Method. The breakpoint regression method has been widely applied in the field of labor education and economic development, and its main theories are as follows: as the government has formulated various laws and policies in the field of labor market and education, breakpoint regression has been widely applied in this field [3]. (1) According to the class size of the education system, the number of classes must be kept within 40, and more than 40 classes must be divided into two classes. Breakpoint regression is used to estimate the impact of class size on people's grades and education quality. The research finds that the smaller the class size is, the better people's test scores are. This paper uses the "cliff" method, namely, the breakpoint regression method, to test the impact of school autonomy on teaching quality, and finds that the proportion of independent school graduates is higher. (2) The breakpoint regression method is used to evaluate the impact of long-term service payment on the labor market. By analyzing the situation of the unemployed aged 50 and above, it can be concluded that the inconsistent duration of unemployment benefits affects the length of unemployment, treatment, and employment method, because the unemployed aged 50 and above have different periods of receiving state benefits. In the field of development economics, the particularity of regional administration is mainly used. In return, the kingdom took full advantage of the fact that the region's formation depended on radiation seeping into the central city economy. If an area is far away from the urban center, the impact of radiation on the economic development of peripheral areas of the central city will be alleviated by the combination of production sectors, complementation of industries, and redistribution of resources. Therefore, zoning is related to the distance between the area and the central city. By comparing samples on both sides of the boundary, the influence of regional formation on regional economic performance can be determined [4]. Taking Beijing, Tianjin, Hebei, urban agglomeration area, Yangtze River Delta, and Pearl River as examples, Yu and Zhao used the breakpoint regression method and component regression method to determine the income differences in urban areas, to form the centralized effect and the radiation effect, and to explore the comprehensive effect of government reform. The prices and values of 37 agricultural

products produced in 224 markets in 15 cities in the Yangtze River Delta region were sampled and investigated. The income differences in the region did not lead to consistent development. Margherita and Marco used breakpoint regression to analyze the impact of provincial boundaries on price differences [5]. Zhang Chuan and Chen Binkai used the breakpoint regression method to explore the impact of the new rural insurance scheme on the rural pension model based on the micro data of China's health and pension follow-up. They found that the probability of the old people participating in the new rural insurance scheme receiving private transfer payments would decrease by 32%-53%. The new rural insurance system has no significant impact on the transfer payment amount of the elderly who receive transfer payments. The social pension model can replace the family pension model to some extent, but the effect is limited, and the level of rural social security needs to be further improved (with age as the entry point). Liu Chang and Ma Guangrong conducted a natural experiment on national and county division in 1994. Using the county-level panel data from 1999 to 2009, this paper reestimated the "fly-paper effect" of fiscal transfer payments by using the breakpoint regression method. With the increase of general and special transfer payments, the proportion of fiscal expenditure to GDP will increase by 1.5% and 3.0%, respectively, in 2015. Zhang Yi and his colleagues use the western development strategy as a natural experiment to analyze the impact of transfer payments on the urban-rural income gap using fuzzy geographical points based on the county-level data of 15 central and western regions in 2000 and 2007. The study found that transfer expenditures in the western region were higher than those in the central region, while the urban-rural income gap in the western region was 20 percent. The results are stable when variables are implemented using different ranges, distances, or measurements as breakpoints. According to the literature analysis, there are many applications and studies of breakpoint regression method, but there are no studies on the topic of this paper, so the research in this paper is somewhat innovative [6].

2.2. Research Review on Body Mass Index and Physical Exercise. Obesity has a variety of harmful health consequences and is an underlying factor in chronic diseases and many other conditions. In earlier studies, most of the literature has focused on physical activity to prevent obesity, as a therapeutic strategy for fat and weight control and as an important aspect of a healthy lifestyle. However, little research has been conducted on the behavior of overweight or obese people who participate in physical activity, i.e., whether obese people spend more time participating in physical activity than normal people or weigh less or whether obese people increase the frequency or frequency of exercise when their BMI is elevated; differences in attitudes and behaviors toward physical activity also vary among obese people, with some fat people actively participating in physical activity while others do not [7].

According to overseas studies, physical activity declines sharply from high school to college. According to overseas researchers, obesity may be a driver of physical inactivity. That is, high obesity rates may be responsible for physical activity in general. In a study of the relationship between obesity and physical activity in adults, researchers found that more than 60 percent of BMI exercised people, suggesting that as BMI increased, the rate of physical activity increased, which is consistent with Banerjee's findings. However, it is unclear whether a higher BMI would encourage people to be more physically active. Fear of injury, lack of skills, lack of finances, and lack of time were the main reasons for lower participation in physical activity among adults. In the case of youth physical activity, overweight or obese people engage in physical activity than the average person [8].

In studies of adult men and women, women were more susceptible to external assessments of their weight or size, as well as to media portrayals and suggestions of the ideal body. Andrew (2000) claimed that in social settings, obese people are discriminated against and stigmatized by others, leading to weight stigma, which is one of the reasons why obese people self-reject exercise and physical activity. According to another study, people with low BMI, low weight, or normal activity engage in physical activity to lose weight. It also corresponds to overweight or obese women who do not engage in regular physical activity. The external social environment can influence obese people to participate in physical activity [9].

Women are more sensitive to body image than men, and they are more likely to feel chubby and obese. According to a study, fewer women and overweight people participated in physical activity. Finding that men or women feel or think they are too big is also a barrier to physical activity, Yiquan et al. analyzed self-perceptions of obesity between men and women [10].

Another aspect of this study showed that obese adults who participated in exercise had physical barriers (hindrances) that limited their physical activity. Miguel argued that obese individuals have higher barriers to physical activity and therefore physical activity participation is negatively associated with physical health markers. Ekakis argues that obese people have a different experience of exercise than people of average weight. Exercise intensity, energy expenditure, interest in activity, and emotions of self-obesity are all factors to be considered (evaluation). According to Aleksandra et al.'s study, boredom, embarrassment, difficulty, and energy-intensive tasks all prevent people from participating [11].

Depending on the level of physical activity, some studies found an opposite relationship or no relationship between physical activity and BMI. According to some studies, those with a lower BMI were more likely to regularly participate in high-intensity physical activity. In addition, studies have not shown a consistent association between obesity and physical inactivity in women, implying that obese and overweight women are more likely to be physically active than women who are not physically active [12].

3. Study Methods and Materials

3.1. Main Concepts

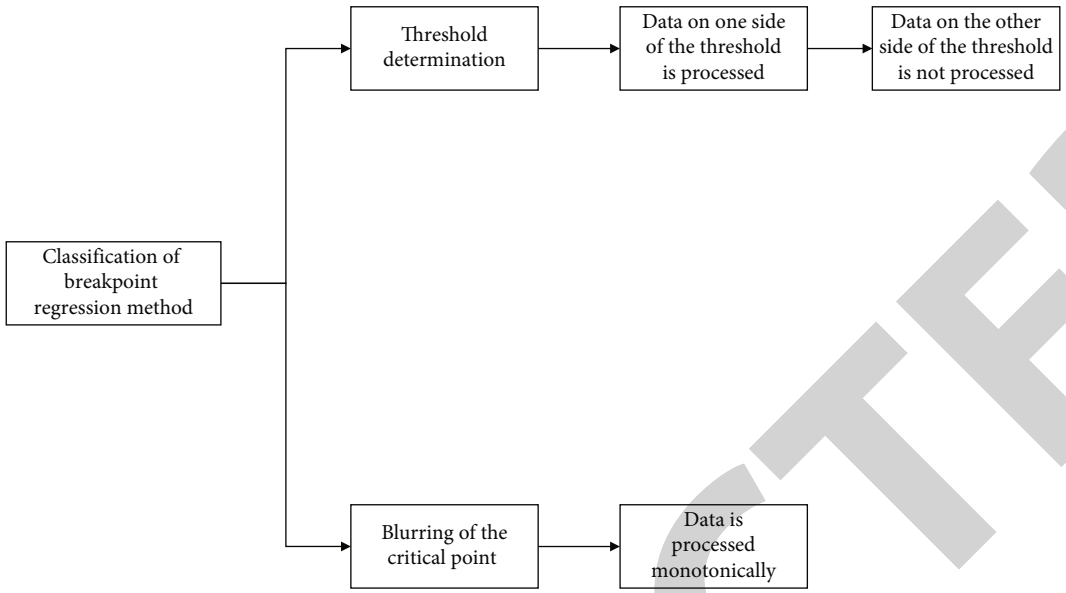

Figure 1: Classification of breakpoint regression methods.

3.1.1. Breakpoint Regression Method. Breakpoint regression is an empirical method based only on randomized experiments that effectively uses real-world limitations to analyze causal relationships between variables. In breakpoint regression, if the variable is greater than a threshold, the variable is processed; if the variable is less than a threshold, it is not processed [13]. In general, the processed data cannot be directly observed. In breakpoint regression, those who do not reach the threshold can serve as a good control group to reflect what is happening in the data processing, especially when the variables are continuous and the difference between the threshold and the sample can appropriately reflect the relationship between sales and economic variables. Breakpoint regressions can be divided into two categories. In the first category, the thresholds are determined, i.e., the thresholds identified in the first category. All observations in other matters are from one side of the threshold and not all observations from the other side. In this case, the probability of removal from one side of the threshold is transferred to the other side. In the second case, the threshold is ambiguous, i.e., other matters in some cases, proving that the systematic variation sampled near the threshold can be used to study the relationship between the predicted removal and other economic variables regardless of the breakpoint regression method [14]. The classification of breakpoint regression methods is shown in Figure 1.

3.1.2. Body Mass Index. Body mass index (BMI) is calculated by dividing body weight (kg) by the square of height (m). It is a global indicator of human weight and health. For statistical purposes, BMI is a neutral and reliable indicator for comparing and analyzing the effects of weight on health in different populations. BMI was originally considered as a statistical tool for public health research. If we need to know if obesity causes any particular disease, we can convert the height and weight of the patient to a weight indicator to see if there is a linear relationship between the number of diseases and their incidence. However, with advances in technology, BMI is only a benchmark. In order to truly assess the degree of obesity in a patient, it is necessary to measure the patient's fat thickness by measuring the patient's resistance. Therefore, the role of BMI has gradually changed—from medical use to the physical condition of the general population [15]. The formula is as follows.

$$\mathrm{BMI} = \frac{\mathrm{Weight}}{\mathrm{height}^2}. \tag{1}$$

The relationship function between height and weight under standard BMI is as follows: this figure is taken when the BMI is 20, where the X-axis is the height of the person and the Y-axis is the person's weight, and the analysis of the figure shows that when the BMI is a normal value, the height and weight are proportional to each other when the BMI is 20, and the relationship function between height and weight under standard BMI is shown in Figure 2.

3.1.3. Physical Exercise. Physical exercise is a kind of physical activity that people do in their spare time in order to exercise their body and mind. The results show that participation in physical exercise can not only directly improve people's physical activity level during exercise but also improve people's overall physical activity level by improving their exercise habits, which can help reduce the incidence of obesity and lower the level of cardiovascular disease risk factors [16]. Physical training especially refers to physical activity with a certain intensity, frequency, and duration that is performed consciously in spare time for the purpose of health protection [17]. Physical activity should be distinguished from physical activity in the field of physical education. The main purpose of physical activity is to promote and maintain physical health, and the purpose of physical activity is to learn motor skills, so that learners can master one or more motor skills and build a good foundation for physical activity. Although they have some common points, the basic points and starting points are different [18].

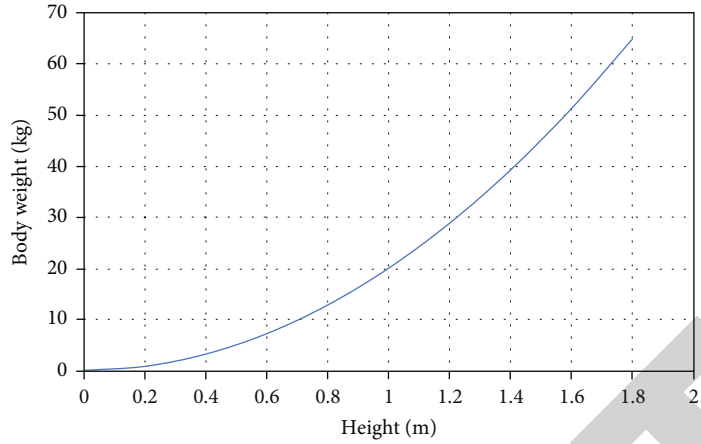

Figure 2: Relationship function between height and weight under standard BMI.

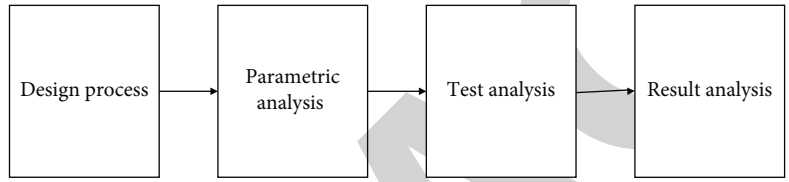

Figure 3: Main design flow.

3.2. Fuzzy Breakpoint Regression Design. The current analysis used data from the China Social Survey (CGSS), a cross-sectional study that began in 2003 as the first national, comprehensive, and continuous academic survey project in China. The CGSS collects data at multiple levels of society, including communities, households, and individuals [19]. This study uses the 2018 General China Social Survey (CGSS). This paper uses breakpoint regression to address endogeneity and appropriately identify the causal relationship between participation rate and BMI. The estimation methods of breakpoint regression are divided into explicit breakpoint regression and fuzzy breakpoint regression. The fuzzy breakpoint regression model was chosen to test for causal effects during model selection, and then, the mechanism regression was used to assess potential influences. The first stage is to determine the presence of jump points, and the most critical step is to conduct extensive testing to ensure that the breakpoints are obvious and convincing. Results and Discussion will provide the results of the fuzzy breakpoint regression and the results of other tests [20]. The main design flow is shown in Figure 3.

4. Results and Discussion

4.1. Analysis of Specific Parameters

4.1.1. Physical Activity and Body Mass Index (BMI). "In the past year, did you regularly use your leisure time to do the following?" Ask participants "During the past 12 months, how often did you engage in 30 minutes of sweaty physical activity per week?" These two items were examined together to determine the respondent's physical activity status. Physical activity was further divided into two categories.

Three exact numbers were set aside for height and weight to remove missing values based on the data from the follow-up survey. BMI was calculated using the kg/m^2 formula. Data smaller than $18.5\,kg/m^2$ were excluded because the relationship between mean weight and overweight and obesity was explored.

4.1.2. Obesity Status. BMI was categorized as normal weight, overweight, or obese. In the final mechanistic regression analysis, obesity status was divided into two categorical variables.

4.1.3. Dependent Variable: Participation in Physical Activity. The dependent variable for participation in physical activity was the rate of physical activity based on the age class of the respondent related to physical activity.

4.1.4. Mechanistic Variables. Mechanistic variables were also aimed at explaining why the breakpoint jump eventually occurs. In this paper, the mechanistic variables are divided into three dimensions: socioeconomic status, physiology, mental health, and degree of social interaction.

4.1.5. Socioeconomic Status. Participants were asked, "In summary, your socioeconomic dimension belongs to today's society." The response options were upper, middle, and lower class. Finally, socioeconomic status was divided into three groups.

4.1.6. Health Variables. Both physical and mental health were considered as health variables. Respondents' overall

Table 1: Breakpoint regression estimates.

Exercise participation rate Estimation method		Whole population Coefficient	se	*z*-value
First-order mounting	Traditional estimation method	(-0.116)***	0.038	-3.02
	Strong estimation method	—	—	-2.49
Second-order fitting	Traditional estimation method	(-0.178)***	0.057	-3.010
	Strong estimation method	—	—	-3.925
Third-order fitting	Traditional estimation method	(-0.146)***	0.047	-3.102
	Strong estimation method			-3.718
	Breakpoint design		24.9	
	Kernel features		Triangle kernel	
	n		6528	

*$P < 0.05$, **$P < 0.01$, and ***$P < 0.001$.

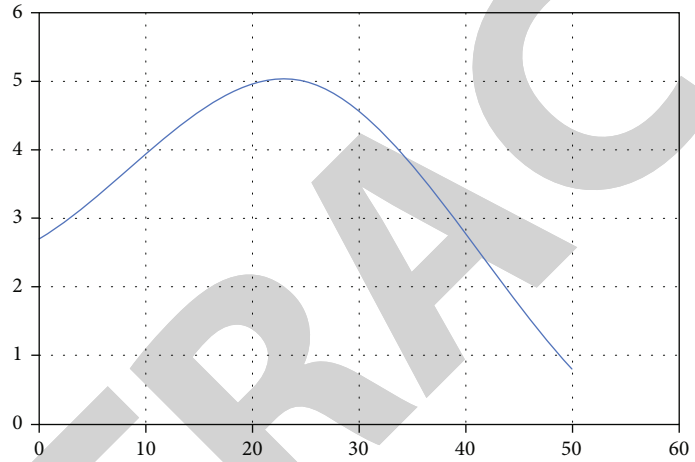

Figure 4: Relationship between BMI and PA rates.

health level is an estimate and judgment of their own health level. Respondents' assessment and evaluation of their level of depression determines their level of mental health. Your perceived current health status and how often you have felt depressed or down in the past four weeks were the questions in the questionnaire.

4.1.7. Social Connection. The purpose of determining the degree of social connectedness was to examine the relationship between the respondents and their relatives and friends.

4.2. Test Analysis

(1) Breakpoint regression estimates: the data are shown in Table 1

(2) Relationship between BMI and PA rate

The rate of physical activity participation in the general population increased considerably before and after a BMI of 24.9 kg/m^2. People with a BMI above 24.9 kg/m^2 were no longer considered normal weight. The PA rate for physical activity climbs and then decreases as BMI increases. On the other hand, people who are slightly overweight or obese value physical activity and actively participate in it. However, when BMI and more severe obesity are reached, exercise at overweight levels may be detrimental to a person's health, so diet and health interventions should be implemented first to lose weight and then gradually regain exercise participation so that the rate of physical activity participation begins to decline in this group. The most important component is the check link. Robustness tests are used to determine if the causal effect of the independent variable causes the dependent variable to jump, to remove interference from other factors, and to ensure stability of the results. Validity testing, robustness testing, nonbandwidth testing, and placebo testing are all necessary to determine if the RD can be approximated by the method. Membership in the group began to decrease. The relationship between BMI and PA rate climbs and then decreases as BMI increases, as shown in Figure 4.

(3) Breakpoint regression requires that the sample data meet specific requirements and that the breakpoints on either side of the breakpoint be smoothed to eliminate breakpoint processing effects. Two methods were used to test the smoothness of the independent

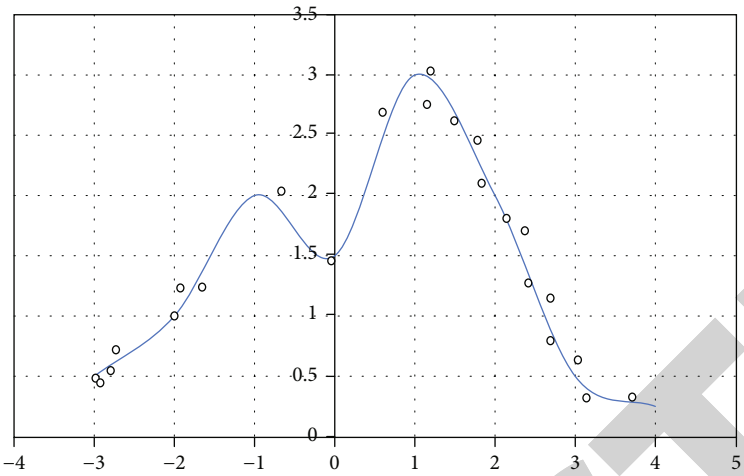

Figure 5: Density functions on both sides of the breakpoints.

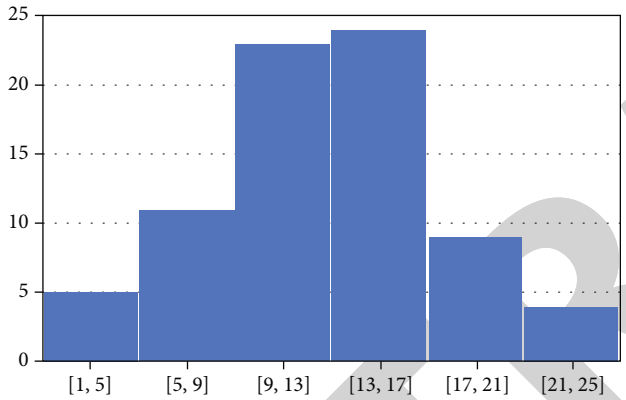

Figure 6: Histogram of independent variable smoothness test.

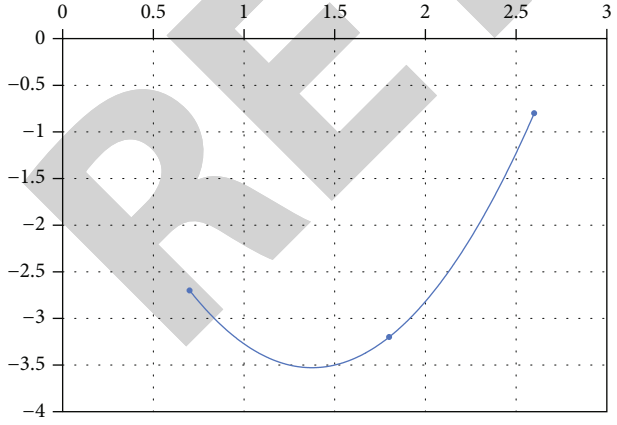

Figure 7: The range of the rectangular kernel function.

variables. First, McCrary (2008) proposes a testing technique for the kernel density function to check that the parameter is smooth and balanced and does not jump at the breakpoints, thus denying the existence of an endogenous group for the parameter.

Figure 5 shows that the confidence intervals for the density function estimates with overlapping breakpoints consist of mostly overlapping, indicating that there is no significant difference between the density functions on the two sides of the breakpoints, as shown in Figure 5

(4) In this paper, the histogram technique is used to test simply and explicitly whether the independent variables satisfy continuous Q and smoothing to verify the accuracy of the test results. Figure 6 shows that the independent variables are continuously smoothed and there are no discontinuity points, as shown in Figure 6

(5) Since the default kernel for fuzzy breakpoint regression is the triangular kernel function, this study evaluates the robustness by switching to the rectangular kernel function. Figure 7 shows that both are shown to be negative when the rectangular kernel function is replaced and the LWALD value changes in an unsuitable range

(6) The concept of RD estimation requires that the estimation sample is selected around the breakpoint and then if the sample size is large enough, a local linear estimation similar to the random experiment can be performed. However, in most cases, we are unable to collect sufficient sample size on both sides of the breakpoint due to the limitation of the actual data. In the case of limited samples, we chose to adjust the bandwidth to test the elasticity of the estimation results. The IK method proposed by Imbens and Kalyanaraman (2012) and the CCT method proposed by Calononocattaneo and Titiunik were used

Table 2: Results in Imbens bandwidth test.

	Model 1	Model 2	Model 3	Model 4
Breakpoint (kg/m^2)	24	25	28	29
LWALD	0.008 (0.88)	0.000 (0.02)	-0.003 (-0.25)	0.005 (0.33)
N	6528	6528	6528	6528

*$P < 0.05$, **$P < 0.01$, and ***$P < 0.001$.

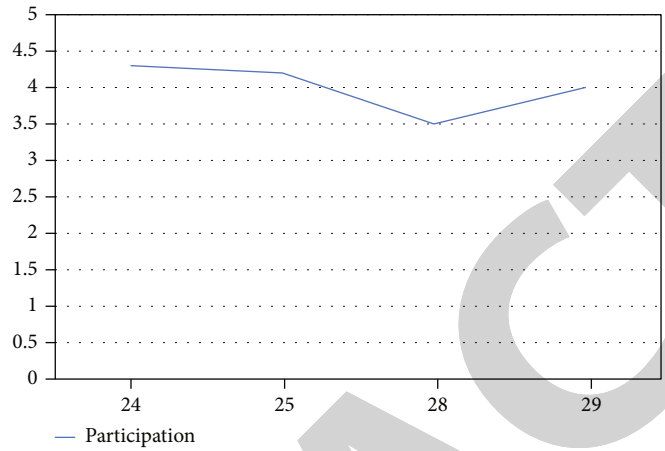

Figure 8: Placebo test.

to determine the bandwidth (2014). The results of the IK and CCT tests are very similar, indicating that the bandwidth is reasonable. The WALD estimates of 0.5x (0.661), the optimal bandwidth (1.323) and the bandwidth of 2x (2.646) were not particularly different in the Imbens bandwidth test and both were negative, as shown in Table 2

(7) Placebo test

The purpose of the placebo test is to see if the breakpoint is indeed unique. The main premise of the placebo test is that the artificial selection of a new BMI breakpoint does not have a substantial effect on physical activity participation; i.e., there is no increase (significant) in physical activity participation at the new breakpoint. If test results showed that physical activity participation did not occur at these breakpoints, 24, 25, 28, and 29 kg/m^2 were chosen as breakpoints in this paper. Jumping can demonstrate that changes in physical activity participation rates can be attributed to BMI (obesity) rather than to other variables. The results of the placebo test are shown in Figure 8, and none of the other BMI values showed a significant increase in physical activity participation at the breakpoint, as shown in Figure 8.

4.3. Test Results. By confirming that there is a significant breakpoint in BMI outside of the usual range and why this leap occurs in people with abnormal weight ranges, a mechanism for further research can be established. Changes in individual behavioral habits are the result of physical activity, which encompasses many interrelated factors. According to Adrian, the social and physical environment is a component that discourages fat individuals from engaging in physical activity.

Obesity is directly influenced by socioeconomic class, and physical activity is similarly influenced by socioeconomic status. Highly affluent individuals have a high degree of autonomy and flexibility in their work, giving them the freedom to set their work hours and schedules without limiting their possibilities for exercise. Overweight and obesity are associated with socioeconomic status, and among both men and women, those in higher economic status are more aware of weight management and work harder to maintain their weight through diet and physical activity. When the obesity variable was not included, the caste and physical activity rates were high and significant in the upper class. This also supports the higher physical activity rates of the upper class. However, when combining the obesity variables, the lower middle and middle classes and the rate of physical activity participation show substantial adverse effects. The lower the socioeconomic status, the lower the rate of physical activity participation.

Lack of exercise can lead to illness and mental health problems, but this can also lead to reduced activity when a person is dealing with negative issues such as illness or mental distress. According to Adrian, social and physical circumstances are components that make fat people reluctant to engage in physical activity. The negative effects of weight stigma in social and physical conditions are detrimental to obese people. One of the reasons for the self-exclusion of fat people from exercise and physical activity is weight stigma. According to Andrew (2000), obese people are

discriminated and stigmatized by others in a social context and face weight stigma, which is a double blow to the body and mind. In Ball's study (2000), it was noted that weight stigma allows many people to give up physical activity altogether. Rebecca's study also showed that weight stigma has a negative impact on health behaviors. When the depression variable did not interact with the obesity variable, depression negatively affected participation in physical activity, but the results were not significant. Obesity and depression had deleterious effects on physical activity when they interacted with obesity factors. Puhl and Andrew found that weight stigma increased mental health problems (depression and anxiety) in obese individuals, which limited participation in physical activity.

When the levels of social interaction and obesity are combined, the effect of obesity on physical activity participation becomes negative. In the absence of an interaction program, the effect of noninteraction and physical activity participation is positive and significant, suggesting that exercise is occurring in a specific context. When people do not engage in social contact, physical activity participation rates decrease. The impact of obesity changes when it interacts with society, possibly due to an alternative coping technique of fat people in the face of social stigma: not socializing, not going to busy fitness centers, and instead doing exercise and other activities alone at home or alone.

In conclusion, there is a direct link between obesity and physical activity participation rates, and more attention should be paid to the individual and environmental influences on exercise behavior. An individual's socioeconomic status, social contact, and health status must all be taken into account in order to design effective methods to enhance individual exercise behavior.

5. Conclusion

In this paper, body mass index and physical activity participation rate were designed in the context of the physical health problem of obesity and combined with fuzzy breakpoint regression method, and the relationship between body mass index and physical activity participation rate design based on fuzzy breakpoint regression design was discussed in this paper. There is a direct link between obesity and physical activity participation rate, and more attention should be paid to the influence of individuals and the environment on exercise behavior. An individual's socioeconomic status, social contact, and health status must all be taken into account in order to design effective methods to enhance individual exercise behavior. Obesity is a global public health problem in modern society. Physical fitness is the quality of the body. It is the property of complexity and relative stability of human structures, physiological functions, and psychological factors that are the basis of inheritance and acquisition. Physical exercise is a kind of physical activity that people do in their spare time in order to exercise their body and mind. With the development of the economy and the improvement of people's living standards, the diet structure is becoming more and more unreasonable, leading to obesity and social care. Nowadays, the international body mass index (BMI) has become the standard for measuring body fat and weight loss. Physical education is a supplement to physical education, a means to fully mobilize motivation and creativity, and an important means to build character and improve physical and mental health. Participation of obese people in extracurricular physical activities helps to enrich their lives, improve their physical condition, and maintain a healthy lifestyle. The problems arising from obesity are as follows.

(1) The physiological consequences of simple obesity: simple obesity is easily induced, penetrates into the heart and lungs, and destroys the function. In most obese people, oxygen consumption increases, cardiac output increases, ventricular filling increases, and centrifugal cardiomegaly occurs. His heart reserves are reduced, the myocardium contracts, the force is reduced, and the heart and volume are larger than usual. Fat accumulates in the chest and abdomen of a fat person. The growth of septum, the limitation of breast movements, and the weakening of lung respiration lead to the limitation of lung respiration and, acutely, to the cardiovascular syndrome

(2) The psychological consequences of simple obesity: simple obesity tends to cause negative emotions, such as depression and low self-esteem. Experts have found that moderately obese children have a more moderate and tolerant personality. In addition, obese children's personality, qualities, and social adaptability are inhibited to varying degrees. Because of their abnormal body image, obese children are often exposed to environmental factors. In particular, families are pressured to worry too much about their bodies. Low tolerance for frustration tends to develop an isolated personality, which leads to impaired self-confidence and motivation to learn and affects intellectual development

Physical exercise has the following effects.

(1) Physical exercise can improve health and brain development. The human thinking organ is the brain, and thinking activities depend on social practices. There are many small muscles in the hands, with which a billion kinds of movements are accomplished. According to brain function localization theory, each small hand muscle has a corresponding "resting point" on the cerebral cortex. In sports activities, due to the frequent activities of small human hand muscles, the cerebral cortex is stimulated, each "brain rest point," and promotes the expansion of the "brain rest point," that is, to promote the development and growth of the cerebral cortex, making people more intelligent. This is the reason for the so-called "dexterity"

(2) Physical exercise ensures that the brain gets food and oxygen, which helps improve thinking and memory. The brain must have adequate nutrition and oxygen

to be healthy, and adequate oxygen and nutrition are directly related to a person's health. Experiments have shown that people's breadth and degree of perception increases after participating in physical activity!" Memory speed increases. This shows that physical exercise can develop one's intelligence. Physical exercise increases the reaction speed of the brain, thus promoting the brain's potential. Human intelligence, especially memory and various parts of the cerebral cortex, is closely related to the level of establishing temporal connections and integrity. Those who regularly participate in physical activity are more susceptible to visual perception, auditory, and other sensory influences. Nerve cells are responsive and have a powerful ability to analyze and synthesize the cerebral cortex. The brain has the function of receiving and selecting, analyzing and judging, processing, storing, and transmitting information. In the physiological sense of the brain, the left brain is used for thinking and analysis, and the right brain is used for emotion and volition. Left brain activity is necessary for the development of creative thinking in the right brain. Right-brain movements based on left-brain activity allow the free use of both brains. This biobrain synthesis is very useful for developing creativity and intuitive imagination. Most of the human brain is undeveloped, especially in the right hemisphere. Physical exercise is a powerful tool for developing the right brain and should emphasize left-handed activities. The complexity, flexibility, and diversity of sports programs are more useful for training people to react quickly, observe and judge accurately, and have a rich imagination and are more useful for developing the brain and realizing its potential

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Retraction

Retracted: A Study on the Design of English Speaking Examination System Based on SSM Framework

Journal of Sensors

Received 8 August 2023; Accepted 8 August 2023; Published 9 August 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] H. Zheng, "A Study on the Design of English Speaking Examination System Based on SSM Framework," *Journal of Sensors*, vol. 2022, Article ID 5239463, 11 pages, 2022.

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Research Article

A Study on the Design of English Speaking Examination System Based on SSM Framework

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At present, the teaching, training, and assessment programs of English speaking courses in schools are basically carried out by the teaching method of face-to-face teaching by teachers, especially in the English speaking assessment; students and teachers communicate with each other to answer questions, while the students' performance is subjectively judged by the school English teachers. This model not only consumes the teaching resources of school English teachers but also cannot ensure the uniformity of grading standards. To this end, this paper designs and proposes an English speaking test system with the aim of building an intelligent speaking test system by designing a speech recognition deepening frequency processing function through SSM framework combined with JSP technology and deep learning theory. The English speaking test system designed in this paper integrates several open source frameworks, adopts modular design, and divides it into two subsystems, student-side module system and teacher-side module system for system framework design, and finally, this system is tested for functionality. The system was designed and implemented through the framework description, functional description, and functional testing of this system, and finally, the English speaking test system was designed and implemented. The system is designed and implemented to change the traditional one-to-one mode of school teaching, save teachers' manpower, strengthen the content of intensive training for students' English proficiency and improve the frequency of exams, facilitate school administrators and English teachers to evaluate the effectiveness of their teaching implementation, and develop corresponding effective individualized teaching and guidance strategies for schools to provide convenience, which can greatly reduce the recognized labor intensity of English teachers and provide a correct evaluation of students, a correct evaluation of the level, and other roles.

1. Introduction

In recent years, computer and web technologies have received increasing attention in education, attributed to the rapid development of computer and Internet technologies [1]. In the field of education in various subjects, computer network-assisted teaching has gradually replaced the traditional offline-only learning mode. In English education and learning, especially in the teaching of spoken English, computer network-assisted instruction has also gradually replaced the traditional offline learning model. For a long time in the past and even up to today, there have been some drawbacks in the English speaking test system in China. The main ones are as follows: the traditional oral English test is usually conducted by means of offline teacher-student dialogue and answering questions, but due to the varying teaching levels in various schools in different regions, it is difficult for English teachers to objectively reflect the true level and strength of the candidates through the traditional test, which leads to a lot of wasted teaching time, consumes a lot of teaching resources, and causes problems such as the lack of fairness in the test problems such as wasting a lot of teaching time, consuming a lot of teaching resources, and causing a lack of fairness in the test [2]. In some places, the teaching of spoken English is neglected to the extent that candidates have fatal shortcomings in English listening and speaking exams, thus not easily bringing out their true level [3]. All provinces and cities in China are now beginning to focus on oral English exams, making them compulsory, and the purpose of oral English exams is to test students' ability to

develop in a well-rounded way, with balanced development in both listening and reading. The purpose of the test is to test the overall development of students' ability to speak, write, read, and write in a balanced manner. This paper is based on the SSM framework to design the English speaking test system with the following implications.

(1) First of all, with the continuous development of China's economic level today, coupled with the continuous development and implementation of the "Belt and Road" national policy plan, as well as the increasing strength of various reform and open innovation measures, English is becoming more and more important, but students tend to learn to read and write English, and the ability to listen is often another learning shortcomings and can not fully meet the current social talent. Therefore, it is necessary to guide the students to learn more and more orally the comprehensive ability of reading and writing. This training system is aimed at gradually transforming the process of learning English oral test into a regular and effective comprehensive general oral test through the arrangement of some simple and effective practice operations and oral practice, according to the main features of the modern English test teaching methods [4]

(2) Secondly, the evaluation system also helps us to improve the learning efficiency of students in terms of daily classroom quality management. The query system also provides a very convenient and fast data input and fast printing of student information reports, which can quickly and automatically realize the query statistics and analysis of each student's performance status. This makes it easier for school administrators and English teachers to evaluate the effectiveness of their teaching and to develop effective individualized teaching and student guidance strategies for the school

(3) Third, the system will greatly reduce the recognized labor intensity of English teachers. Our existing examination system, for manual correction, is cumbersome and heavy workload, so the design of the oral examination system can change this existing limitation of oral examination, improve the quality of teaching, and improve the actual level of students' speaking and listening [5]

(4) Fourth, this system can be analyzed by deep learning algorithms, feature extraction of each evaluation and score criteria of oral test questions, according to the previous students' oral test question scores, evaluation of each oral test question, and degree of difficulty and can roughly predict the average score of an exam, thus giving a reference to the question, the correct evaluation of students' level [6]

2. Background of the Study

Through the analysis and investigation of various English speaking training test markets at home and abroad in recent years, it is found that various computer tools and microcomputer system technologies have also been widely and well practiced in English speaking learning aids and tests in various countries, among which the most typical representative value technologies at present are telephone voice pass system development and Fudan Tianyi voice telephone pass system, based on Fudan Tianyi's system. The developed English speaking ability test system is a test system that is easy to obtain excellent test results [7]. One of its main representative projects, the telephone pass system, is another international patented technology of the American company Odette, Inc., and is a telephone English speaking proficiency test mainly for social-wide use. The procedure of this system program is as follows: (1) first, the candidate registers at the prescribed test center and obtains the pass number and the test paper; (2) then, he or she calls and accepts the test according to the phone number on the test paper; (3) immediately afterwards, the system transmits the candidate's voice over the phone, and when the voice is transmitted to the computer system of the test server, automatic scoring can be performed. Immediately after this system transmits the candidate's voice over the telephone and when the voice is transmitted to the computer system of the examination server, automatic scoring can be performed. Candidates take the computerized test at the designated test time and place and test center location, respectively, as needed; (4) a few minutes or an hour after the final voice upload, candidates can log in to the website for downloading the score report inquiry. Another representative is Fudan Tianyi English speaking test system; the test steps under this system are as follows: (1) after the candidates register at the designated test center, the test center will issue the candidates admission tickets; (2) the computer test is adopted by the test method which is through real-time human-computer dialogue, and dozens of candidates can be concentrated in a computer classroom at the same time to participate in a test; (3) The person responsible for reading the students' papers is a randomly organized teacher from the examination and testing center, and the method of reading the papers can be achieved through computer-assisted online methods. (4) The marker downloads the student's performance report and then sends it to the relevant candidate [8]. The advantages of the Fudan Tianyi English speaking test system are that it allows for large-scale and centralized testing. There is also a testing system, Qiming Oral Test System, which has similar significant disadvantages of separating the test system from the grading system and students not knowing the results soon after the test [9].

Therefore, in order to improve the current situation of English oral test and overcome the limitations of English oral test, there is an urgent need to design an English oral test system that integrates test setting and scoring. In addition, the difficulty of proposing questions for oral test papers is sometimes often more difficult to self-control. According to the specific requirements of the national English speaking

test regulations, the oral comprehensive test still mainly tested the students' overall real speaking ability effectively through a combination of three types of exam questions: English reading aloud, dictating short answer words, and English discussion dialogues. The test is designed to prepare English students for their daily exams and to develop the habit of learning English vocabulary and using English to demonstrate their speaking ability. If an English test is given at once, the speaking test questions are too simple, which leads to little discrimination in students' test scores, and the test questions have a very low propositional effect and degree, which cannot really detect students' oral pronunciation and possible problems with intonation [10]. If the English speaking comprehensive test propositions are also too complex and difficult, it will lead to very low overall scores achieved by the test students, and the assessment results will not meet the basic purpose of English language testing, undermining the test students' motivation to learn actively and speak English well [11]. On the other hand, in order to effectively strengthen English students' comprehensive oral communicative listening ability in English and avoid blind rote memorization, the question markers tend to select only any one of the multiple forms of listening materials that candidates need to provide to in the mock exams as the designated test reading materials, but it is because of the difficulty of being controlled by the various types of reading questions mentioned above that students face the designated test listening materials. The structure is simple and difficult. The test material to be selected will have a direct impact on the final test results, and the test may be extremely unfair [12].

Therefore, how to control the difficulty of various types of materials within the general range is a key issue in the current speaking and language test propositions. In response to the existing deficiencies in the current oral English proficiency test assessment system mentioned above, this paper is an attempt to study the use of various information technology tools to solve the existing limitations and some deficiencies in the current oral English test assessment system; in response to some deficiencies in the current oral English test assessment system mentioned above, this paper is an attempt to study the use of some information technology methods to analyze and solve the existing oral English. This paper is an attempt to use some information technology methods to analyze and solve the limitations and deficiencies of the existing test scoring system of spoken English and to combine the more in-depth and extensive knowledge of foreign language learning with the study of the proposed questions in order to make the test of spoken English more realistic, to better reflect the actual English level of students, and to provide a reference of the difficulty of various materials in the test of spoken English, so that the difficulty and ease of the proposed questions can be controlled within a certain range to reach the level of spoken English, so as to better to have a positive and counterproductive effect on English teaching [13].

3. Research Methodology and Materials

3.1. SSM Architecture. SSM is an abbreviation for three open source technologies Struts2, Spring, and MyBatis [14].

3.1.1. Struts2 Technology. Struts2 integrates and develops the Struts1 web work and integrates and develops the Struts1 web work. Struts2, the web framework, is a well-tested component-based software engineering and reliable and thus does not have to waste time on complex code engineering [15]. Thus, solutions to similar problems are extracted into an application framework that is easy to extend, so to say increasingly popular, which means that people will have enough time to analyze and build business logic and logical applications; however, there is no wasted space because the system can recover the wasted resources in time and not be limited to the dependence on the web container.

3.1.2. Spring Technology. Spring is a solution that extends to all layers. It runs through the presentation, business, and persistence layers of the application. However, integrating Spring has two main features: control inversion and dependency injection. In traditional Java programming, control inversion and dependency injection are used when you use objects [16]. In traditional Java programming, when you use objects, the core of MVC-Spring is integration, which is forwarded by the server controller. The controller calls the handler mapping class to complete the mapping of the request to the corresponding handler which handles the request. If the Spring controller calls the handler map class to complete the mapping of the request to the corresponding handler, the handler processes the request. If then the handler map maps the request to the right handler controller, the data retrieved from Dao will be stored in the model and viewed; then, you need to call some service or Dao in the controller to manipulate the data [17].

3.1.3. MyBatis Technology. MyBatis provides the transparency of the database operation and loads it into JDBC. MyBatis revolves around the SqlSessionFactory example. MyBatis files and entity class configuration files modify the configuration of each class mapping file to display the SQL words required by the database. Every time the database interacts with it, it gets the SqlSession through the SqlSessionFactory and then runs the SQL commands [18].

3.2. JSP Technology. The main tool used in this paper is design thinking, i.e., other things to make the application cross-platform and easy to build; we have chosen the popular JSP to create web pages. JSP has many advantages. Web pages generate dynamic content, enabling you to create web applications easily and quickly. It can also be used on multiple platforms. A JSP page is a simple service that is converted into a servlet on the first request [19].

In JADE, the database is connected through JDBC technology. Only after connecting to the JDBC driver, the database can add, delete, modify, and query operations accordingly. Most databases include ODBC drivers, so JADE can also connect to databases such as Oracle, Sybase, MSSQLServer, and MSAccess through ODCB drivers. In addition, the development of personality databases has contributed to the improvement of JSP methods. Developers can use it to create their own databases. This allows web developers to use token repositories like familiar tools [20].

The technology supports interstate platforms, and with a range of technical tools, JSP can be extended to enterprise-level support and decentralized applications. Because JSP is part of the J2EE system architecture, it is Java-based. As a result, JSP technology can support more complex web applications. Java has all the advantages that apply to JSP, such as sophisticated inventory management and security mechanisms and multiplatform support.

3.3. Deep Learning Theory. The principle of deep mining distributed machine learning is to use multiple data hidden layers to extract some underlying data features; each hidden layer is equivalent to a data perceptron, which can obviously and effectively alleviate the minimum problem of underlying data localization. This is a representation of distributed deep learning features by using a data perceptron to extract some low-level features and then by recombining all these low-level features to form a more complex and abstract representation of the high level data. In this paper, we focus on the application of deep learning in speech recognition. The following is based on the time-frequency decomposition in speech recognition.

Time-frequency decomposition is the front-end processing module of the whole system. By time-frequency decomposition, the input one-dimensional time-domain signal is decomposed into a two-dimensional time-frequency signal.

Suppose $w(t) = w(-t)$ is a symmetric function, $X(t, f)$ which is the short-time Fourier $x(k)$ transform t coefficient of the f one-dimensional time-domain signal at the first time frame and the first frequency band, then

$$X(t,f) = \int_{-\infty}^{+\infty} x(k)w(k-t)\ \exp\ (-j2\pi fk)dk. \quad (1)$$

The corresponding Fourier energy amplitude spectrum $px(t, f)$ is

$$px(t,f) = |X(t,f)|, \quad (2)$$

where $||$ denotes the mode-taking operation in the complex domain. To simplify the symbolic representation, a vector is used $p \in \mathbf{R}F+ \times 1$ to denote the magnitude t spectrum of the time frame F as, here, the number of bands of the Fourier transform. The short-time Fourier transform is complete and stable and can be reconstructed exactly from by the $X(t, f)$ short-time Fourier $x(k)$ inverse transform. That is, the separation or enhancement of speech can be achieved by estimating the short-time Fourier transform coefficients of the target speech.

$$x(k) = \int_{-\infty}^{+\infty} Y\hat{}s(k)w(k-t)\ \exp\ (j2\pi fk)dfd. \quad (3)$$

4. Results and Discussion

4.1. Principles of System Design. System design is a key stage in its whole life cycle, which is the process of system from requirement analysis stage, theoretical to practical transfer of specific software to customer process. Therefore, in the design process of the English speaking test system, the system design follows the following principles according to the characteristics of the system design.

(1) The system should satisfy the user-centered principle: only if the given functions are not easily changed according to the needs of the English speaking test, the final developed system can meet the actual needs of the English speaking test. In the design process, if there are any requirements that deviate from the functional needs of English speaking test, they must be considered carefully

(2) The system should meet the principle of security: after the system is completed, a large amount of English speaking test information will be stored in the data storage system. Once an unknown hacker attacks the system, the loss cannot be estimated. Therefore, the system needs to consider not only the relationship between each module but also the logical requirements of the whole system design framework and the factors that need to be considered

(3) The system should satisfy the principle of scalability: after the spoken test system is established, it needs to be continuously expanded. Therefore, in order to reduce the cost of future R&D, the corresponding software development interface should be left in the early development process of the system to leave some space for future system expansion and improve the scalability of the system

(4) The system should meet the principle of portability: after the system is developed, it needs to be portable in order to be able to run on multiple platforms. Therefore, developers need to ensure only the perfection of the system functional modules in the system design process, but also to ensure the portability of the system, the system should support a variety of browser access, reflecting the portability of the system

(5) The system should meet the principle of high efficiency: system software developers in the system analysis, development, and testing process whether to have a perfect function to ensure that the system can run continuously and efficiently, a good user experience

(6) The system should meet the principle of stability: this principle is intuitive and important; it involves whether the system can be stable and whether the system will have a series of problems in the future after the actual operation. Only in this way can the quality of the system be guaranteed and the long-term stability of the system operation be ensured

4.2. System Description and Construction. In this part, through the analysis and design of the SSM framework design combined with JSP technology and deep learning theory of the frequency decomposition function in speech recognition, the system is built and designed as follows.

4.2.1. Overall Technical Architecture Description. According to the requirement analysis of the system, a three-layer architecture is adopted for the complexity and business requirements of the English speaking test system. The English speaking test system adopts a three-layer structure, including application layer, logic layer, and data layer. The application layer includes three parts: teacher management module, student management module, and system management module. For different user groups, a style that meets the needs of such users should be adopted. Therefore, developing the interface layer also requires market research. The logic layer mainly deals with business logic and can be developed independently of the interface layer. The logic layer is based on the interface and information layer; processing through the technical logic, processing will be the most accurate requirements, then, passed to the data layer, the database, and then the corresponding processing to obtain the numbers; there is a logic layer through, and the interface layer will be displayed when the final processing is completed. The data layer logic is simple; the main function is to construct SQL statements, exchange with the database, and insert data during the data collection process. The technical architecture is shown in Figure 1.

As shown in Figure 1, the system uses multiview control, and the hierarchy is implemented using the software system management framework model. In the system, the view layer is implemented using hypertext markup language, CSS, JSP, and other technologies, and the interaction is done using JavaScript technology, collaboration between users and the web system. When a user uses the system, the representation layer generates a request and then encapsulates it in the most common http protocol packets. Meanwhile, the Struts controller keeps listening. When the request is intercepted, it hands over control of the request to the appropriate business controller. The business logic layer is the most important core layer of the entire framework and is used to encapsulate all business operations and rules. The operation of the whole system is concentrated in the business logic layer. As shown in Figure 1, the representation layer sends a Vo (value object) request to the front-end control layer, and this request is intercepted by Struts and transmitted to the business control layer. In the business control layer, the Vo is assembled into the data required by the business logic layer and then transmitted to the business logic layer. The service logic layer receives the data transfer object (dto) from the service control layer, extracts the data from the dto and repackages it as an entity object (eo), then calls the service processing method to locate the persistence operation component Dao, and assigns the eo object to the corresponding do method to complete the persistence operation of accessing the database and waiting for the result to be returned. The business logic layer receives data from business objects, converts business objects into data and data objects, and returns data objects to the business control layer according to the execution of business rules, and the service control layer converts data objects into virtual objects, which are displayed by the front-end controller on the representation layer page. The data access layer provides database access, file data access, and other LDAP and memory database data access functions. The business logic layer mainly provides job management, performance management, basic information management, and attendance management for basic components (such as user management and resource management). The representation layer supports client-side rendering technologies, such as hypertext, markup language, CSS, JavaScript, Ajax, and server-side rendering technologies, such as JSF. The user terminal is a terminal device that provides a system interface for users to use on personal computers, laptop computers, etc.

4.2.2. Description of the Overall Functional Architecture. Firstly, the overall relationship network diagram of the English speaking test system is designed. The English speaking test system management is divided into two main parts; one is the English teacher port, and the other is the student port. The teacher port includes online class management, online student management, online marking management, and online exam question bank management; the student part includes online mock exams, online score inquiries, etc. The overall relationship network diagram of the English speaking test system is shown in Figure 2.

4.2.3. Subdivision of Functional Architecture Relationship Network. The online class management includes online class import, online class addition, online class modification, online class deletion, and online class modification; online student management includes batch import, batch addition, selection deletion, information modification, etc.; online paper marking management includes online correction. The online examination question bank management includes question creation, question modification, question selection, and question export. The operation of the teacher port system is broken down as shown in Figure 3.

The online mock exams and online score inquiries of the student port are subdivided. The online mock test includes English oral reading, recording, and uploading; the online result query includes student information input, result ranking result display, and result detail report export. The operation of the student port system is broken down as shown in Figure 4.

4.2.4. Specific System Operation Flow. Candidates should first check whether the hardware of the computer used is correct after logging in. To ensure correct equipment, the examiner must be able to clearly read the session audio files saved during the exam and record the session completely and clearly during the exam. The exam is auditioned. At the end of the exam, the student clicks on the "start test" button to open the exam screen. On the left side of the interface is the English text that students must read aloud. Students click on the reading record while stopping the recording as appropriate. After playing, click "stop" and then "download" to save the recording to the platform server. Students use the client interface to select one of the many simulation options and then click on the appropriate test button to take the test. Before the test, the platform provides the student with a hearing through the interface to ensure that the hardware and software are in good condition. In the headset, click

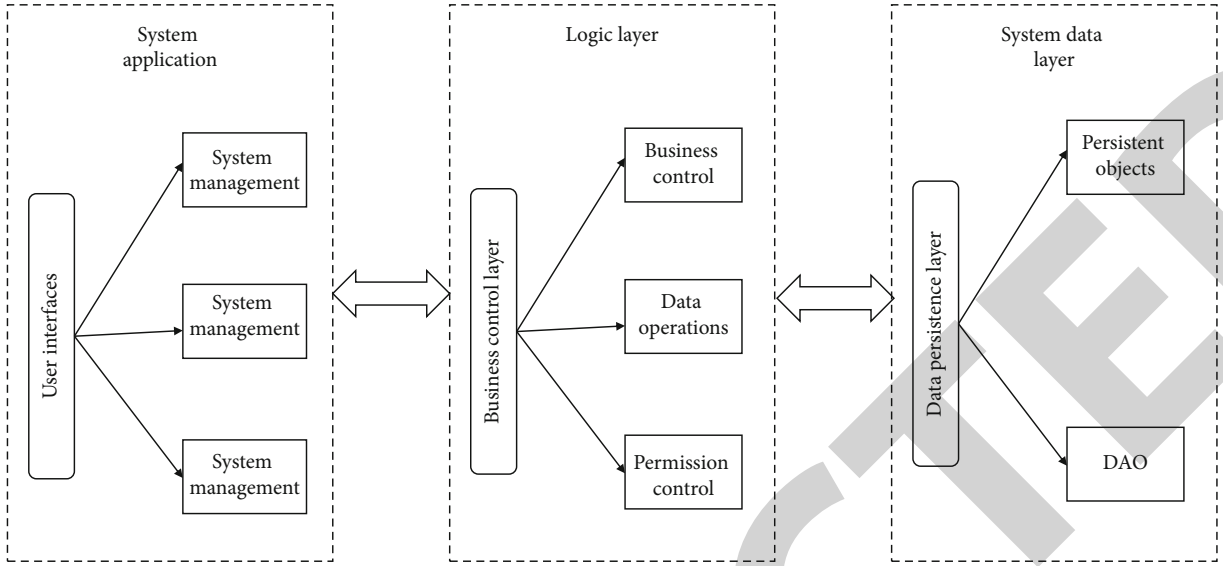

Figure 1: English speaking test system technical architecture diagram.

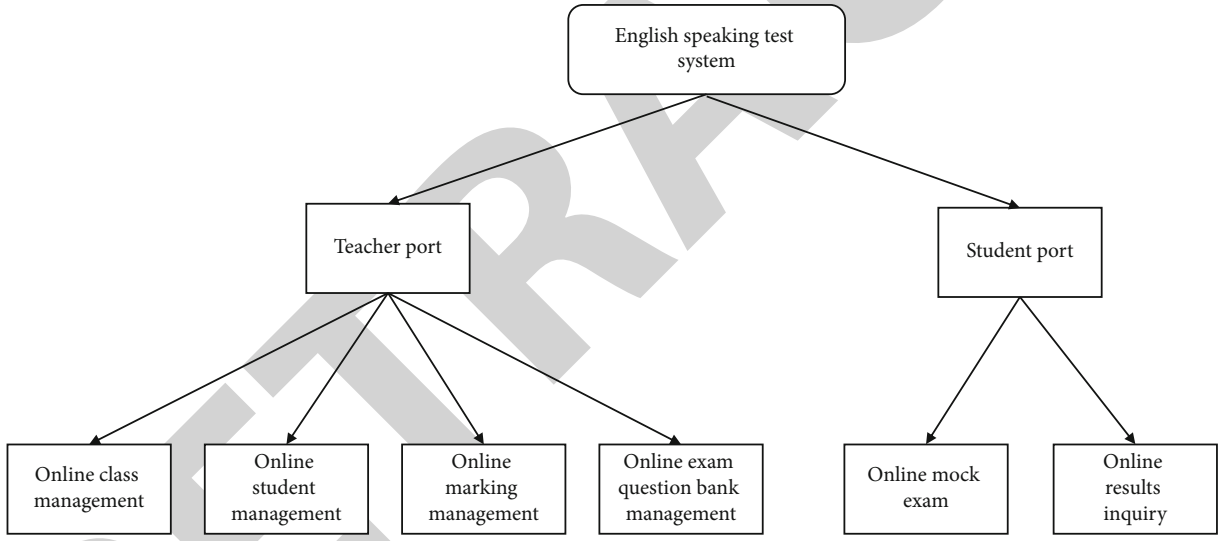

Figure 2: The overall relationship network diagram of English speaking test system.

on the "check headset" button in the client interface to determine if the headset is working properly by playing the tone; click on "test headset" to read the short text displayed on the platform and determine if the microphone is working properly based on the platform recognition results. After testing the sound, you can continue with the simulation test. Student users can choose to continue practicing and repeat the test, or click the previous button to select another test. After completing the test, you can view the test results, scores, missing items, and reference answers through the platform interface. Also, short text will appear on the right side of the platform interface, which can be intelligently recognized by the student's pronunciation. This system should also ensure that test papers are submitted correctly upon submission. Unlike other programs, the examination system and network cannot be used during the entire examination process. Also, no other programs that are not related to the exam may be turned on. This system completely overshadows any other factors that may hinder the exam. The main functional requirements of the Internet English test system were divided into two subgroups according to the requirements of the users. First, English teachers use the software. Candidate information management includes candidate information entry, modification, deletion, test score verification, stamping, and test planning. In particular, the results of the student performance survey provide information not only about the individual results of candidates but also about the results of students. English teacher information includes the addition, modification, and input of English teacher information. Different English teachers have different rights, such as editing

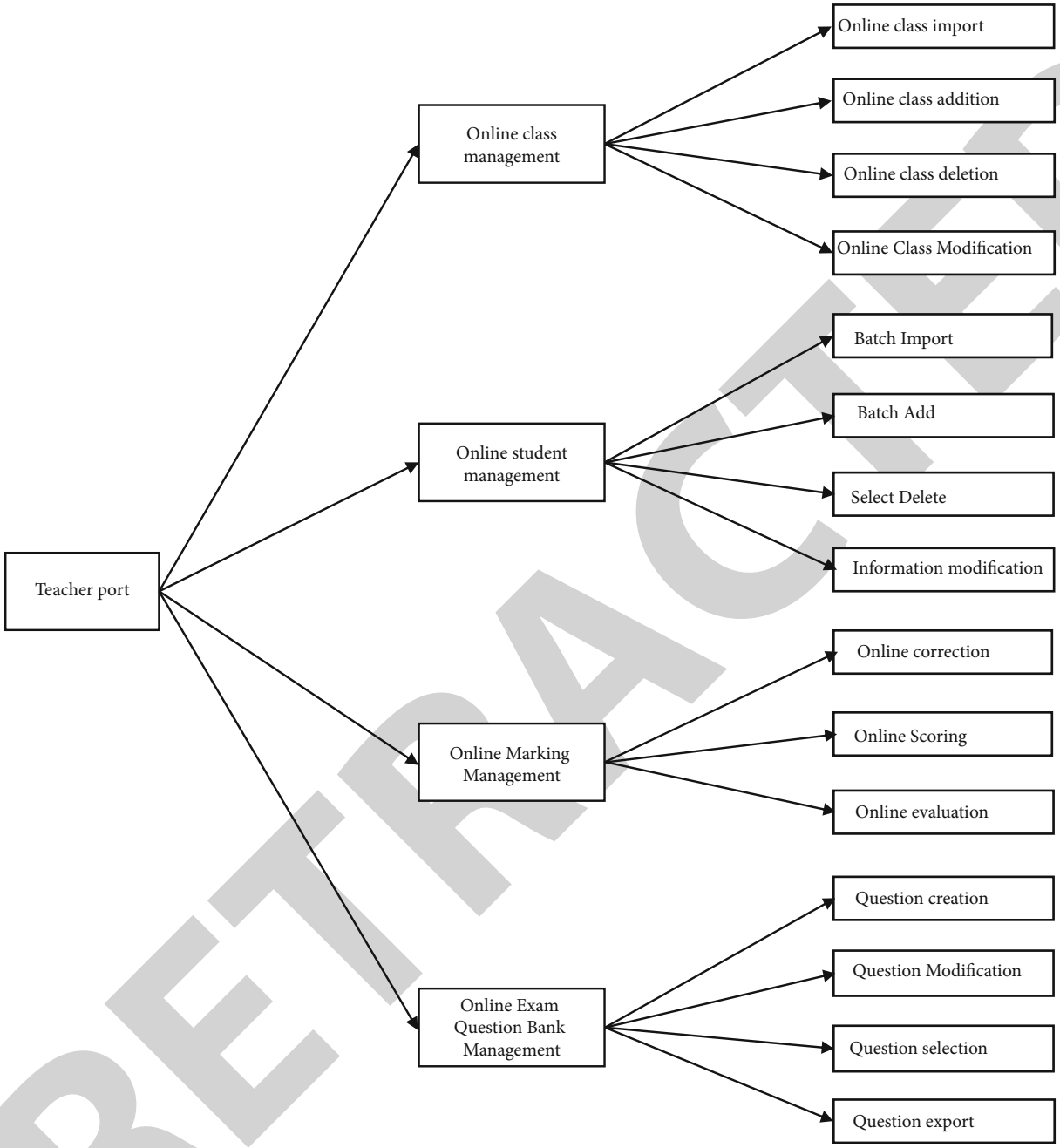

Figure 3: Teacher port system operation subdivision.

rights and rights restrictions in the test center. When passing exams, English teachers must obtain original test papers, test records, and computerized answers and then assess the completeness, clarity, tone, and accuracy of the content of each exam, as well as suggestions and comments. Finally, the total score of each examinee is calculated, the scores and data of all students are stored, and the scores of all questions are extracted as teaching data to build a neural network model. Students can use this software to search for test scores, including test name, test date, class, grade, and other and take online English speaking test.

4.3. System Functionality Testing. Based on the above design of the English speaking test system, an elementary school, middle school, high school, and university in region A were selected as the pilot to conduct a functional test of the English speaking system using this system thus drawing the following conclusions.

(1) Compared with the traditional English speaking test, the efficiency of students using this system for online testing is significantly higher: 4.5 hours for elementary school, 6 hours for middle school,

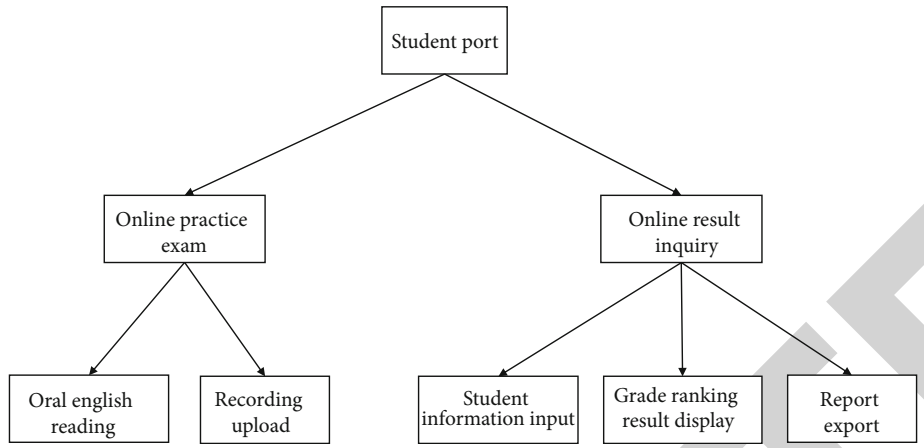

Figure 4: Student port system operation breakdown.

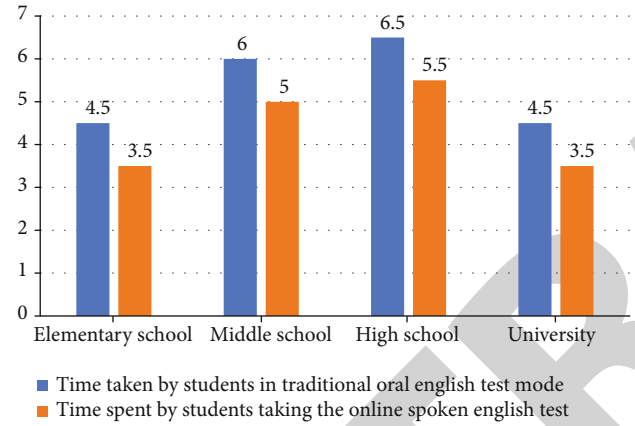

Figure 5: Comparison of time spent by students taking the test in online versus traditional English exams.

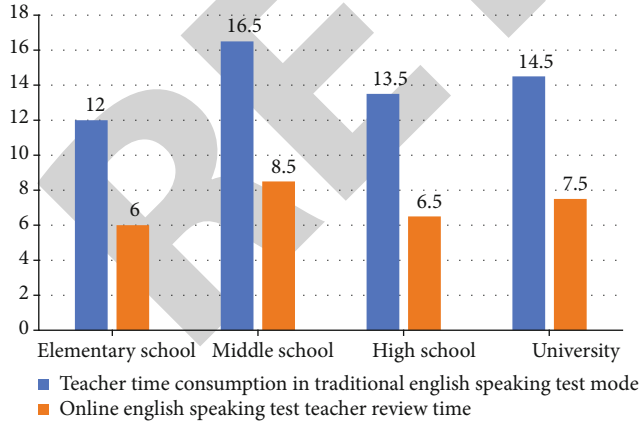

Figure 6: Online vs. traditional English exams in terms of teacher's time spent on grading.

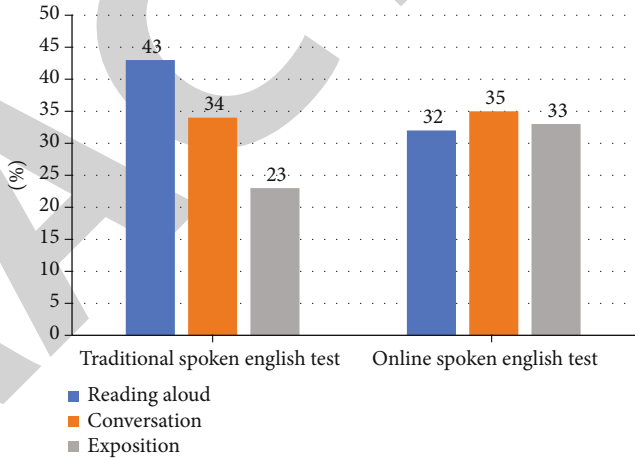

Figure 7: Percentage of online and traditional English test types.

6.5 hours for high school, and 4.5 hours for university using the traditional test mode; offline English tests are often assigned to students in batches and usually cannot be taken at the same time, so more time is needed to test students, while online. The offline English test is often assigned to students in batches and usually cannot be taken at the same time, so it takes more time for students to take the test, while the online oral English test can be taken by more than one person on the computer at the same time, which greatly reduces the length of the test, specifically, 3.5 hours for elementary school, 5 hours for middle school, 5.5 hours for high school, and 3.5 hours for college, as shown in Figure 5

(2) English teachers are also much more efficient at scoring students online than they are at marking traditional speaking tests, which requires teachers to carefully record students' speaking abilities during the test and has certain limitations. It takes a middle school English teacher 16.5 hours to grade, a high school English teacher 13.5 hours, and a college English teacher 14.5 hours to grade, while in this online test system, the marking time is shortened to 6 hours for elementary school English teachers, 8.5

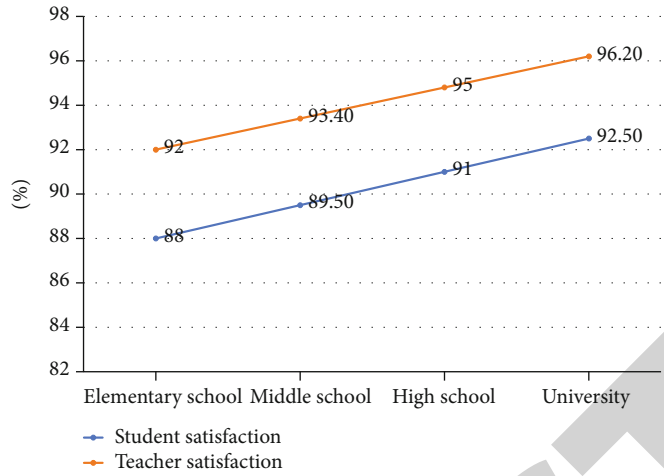

Figure 8: Comparison of teacher and student satisfaction with the online English speaking test system.

hours for middle school English teachers, 6.5 hours for high school English teachers, and 7.5 hours for college English teachers; our existing examination system, for manual correction, is very troublesome and workload, so the design of the oral examination system can change this existing limitation of oral examination, improve the quality of teaching, and improve the actual level of students' speaking and listening, so the addition of the system greatly shortens the length of English teachers' grading, improves work efficiency, saves teaching resources, etc., as shown in Figure 6

(3) Compared to the traditional English speaking test, the online English speaking test has a richer and more innovative question type, which is more likely to detect the students' true level of proficiency, and the results are objective and nonlimiting. It is difficult to see students' overall ability, especially their independent play. The online English speaking test avoids this point, with the reading part accounting for 32%, the conversation part accounting for 35%, and the expository part accounting for 33%; all three major English speaking tests occupy a relatively consistent share of the content, which has a great effect on the improvement of students' overall ability and can reflect the true level of students, making the speaking test more fair and allowing students to develop more comprehensively. The test should be designed to prepare English students for their daily exams in foreign languages and at the same time to develop good habits of learning English vocabulary, using English, and showing their speaking skills through the test. If an English test is given at once, the speaking test questions are too simple, resulting in very little discrimination in students' test scores, and the test questions have a very low propositional effect and degree, which cannot really detect students' spoken pronunciation and possible problems with intonation, as shown in Figure 7.

(4) Online English test satisfaction survey: English teachers and students from elementary schools, middle schools, high schools, and universities were selected for satisfaction testing. The data showed that elementary school students were 88% satisfied with the online English speaking test system, elementary school teachers were 92% satisfied, middle school students were 89.5% satisfied with the online English speaking test system, middle school teachers were 93.4% satisfied, and high school students are 91% satisfied with the online English speaking test system. The satisfaction rate of high school students is 91%, the satisfaction rate of junior high school teachers is 95%, the satisfaction rate of university students is 92.5%, and the satisfaction rate of university teachers is 96.2%. The data analysis shows that both primary, middle, high school, and university teachers and students are very satisfied with this online English speaking test system and are willing to use it for English speaking test, as shown in Figure 8

Compared with the traditional English speaking test, the efficiency of the English teachers in scoring the students online is also greatly improved. The online English speaking test is much more rich and innovative than the traditional English speaking test, and it can detect the students' real level, and the score is objective and nonlimiting.

5. Conclusion

In this study, an English speaking test system was designed and developed to address the shortcomings of the traditional English speaking test method. In this paper, we designed and proposed an English speaking test system, aiming to realize intelligent speaking test, and the whole design was realized through SSM framework design combined with JSP technology and deep learning theory of speech recognition deepening frequency processing function, integrating several open

source frameworks; under the guidance of software engineering theory, the system went through the steps of feasibility study, requirement analysis, general design, detailed design, and testing. Then, the system was finally designed and implemented by combining the popular system development language programming technology and powerful database management system database and emerging reinforcement learning technology. The main research results of this thesis are as follows: the online English speaking test system is designed and developed and is divided into two subsystems using a modular design: a student-side module system and a teacher-side module system. Among them, the student test subsystem mainly implements the functions of login system, class management, student management, marking management, test bank management, result statistics query, online test, and result prediction. The oral test system is aimed at establishing a communication platform for teachers, students, and managers in the daily English speaking test process, to change the oral test process as a regular test, to change the existing model, to save manpower, to improve the frequency of students studying for the test, to change the old pair of models with oral test as a general test, to save human resources, to help improve the efficiency of daily classroom management, and to greatly reduce the work intensity of English teachers. Improve the efficiency of staff work, and focus on education and research. In addition, this change in format would allow the English speaking test to better reflect the actual speaking level of the students. In order to address the problems of wasted teacher resources and inconsistent test scores, the government has implemented a new initiative to improve the quality and performance of teachers. This system serves the following purposes.

Firstly, the training system is aimed at gradually transforming the English oral learning process into a regular and effective comprehensive general speaking test through the arrangement of a number of simple and effective practice operations and speaking practice, based on the main features of the modern English test teaching style.

Secondly, the evaluation system also helps us to improve the learning efficiency in the daily classroom teaching quality management of students. The query system also provides convenient and quick data entry and fast printing of student reports, which allows for quick and automatic querying and analysis of each student's performance status. It is convenient for school administrators and English teachers to evaluate the effectiveness of their teaching implementation and to develop effective individualized teaching and guidance strategies for the school.

Third, the system will greatly reduce the recognized labor intensity of English teachers. Our existing test system, for manual correction, is very cumbersome and work-intensive, so the design of the oral test system can change this existing limitation of the oral test, improve the quality of teaching, and improve the actual level of students' speaking and listening.

Fourth, this system can be analyzed by deep learning algorithm, feature extraction of each evaluation, and score criteria of oral test questions, according to the previous students' oral test question scores, evaluation of each oral test question, and degree of difficulty and can roughly predict the average score of one test, so as to give a reference to the question, the correct evaluation of students' level.

Therefore, the study on the design of English speaking test system based on SSM framework has great feasibility and application value.

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Research Article

A Support Vector Machine Based Prediction on Sensitivity to Coal Ash Blast for Different Degrees of Deterioration

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Coal ash blast is a potential hazard that causes serious disasters in coal mines. In explosion control, research work on coal ash sensitivity prediction is of practical importance to improve accuracy, reduce blindness of explosion protection measures, and strengthen targets. The potential and destructive characteristics of coal ash blast vary greatly from coal to coal, especially in coal mines with complex and changing environments, where the characteristics of coal ash blast show great variability under the influence of various factors. In addition, due to the lack of systematic and comprehensive understanding of the occurrence mechanism of coal ash blast, it is necessary to conduct systematic research on the occurrence mechanism of coal ash blast. Current coal ash blast sensitivity summarizes and concludes prediction methods to create reliable predictions for coal ash blast. A new general learning method, support vector machine (SVM), has been developed, which provides a unified framework for solving limited sample training problems and can better solve small sample training problems. With the purpose of determining the coal mine problem and coal ash sensitivity prediction sensitivity indicators and thresholds, the SVM method is used to set the sensitivity function of each prediction indicator, and the sensitivity of each prediction indicator for the proposed study mine is expressed quantitatively. The experimental results show that the prediction accuracy of SVM for positive and negative categories is 15.6% higher than that of BP neural network and 35.1% higher than that of Apriori algorithm. Therefore, the prediction effectiveness of the SVM algorithm is proved. Therefore, it is practical to adopt SVM method for prediction on sensitivity to coal ash blast and apply the latest statistical learning theory SVM to predict the risk of coal ash.

1. Introduction

Coal ash accidents are mainly coal and coal ash protrusion, coal ash blast, and coal ash asphyxiation injuries [1]. When such events occur, they not only cause significant losses to local mines and affect the normal process of coal production but also often cause incalculable economic and psychological damage to the employees of the enterprise, miners, and their families [2]. The frequency and intensity of coal mine accidents are alarming, and the level of safety management is still far from that of developed countries, especially because of insufficient safety investment [3]. It causes extremely bad social impacts and huge economic losses [4]. Coal ash itself is a hazard that not only has the potential to cause secondary or chain explosions but also can easily explode together with flammable and explosive gases [5]. This will further increase the potential and fatal hazards of coal ash blast accidents [6]. Therefore, there is a very complex nonlinear relationship between the degree of coal ash blast and the gas product, and the state of coal ash blast can be determined by monitoring.

Prediction on sensitivity to coal ash blast is the first link in the comprehensive measures of gas disaster prevention and control, and it is also a decisive link to ensure safe and efficient production in hazardous coal seams [7]. The degree of blast damage varies from large to small, and the intensity of the explosion varies [8]. This is related to the dust content and particle size of the coal ash involved in the explosion and the quality of the coal in that mine [9]. All current monitoring systems for coal ash focus on coal ash monitoring, which truly records data and provides, but does not provide, early warning of coal ash concentration exceedances [10]. As

a result, much historical data from coal ash concentrations are not reasonably available [11]. Data-driven machine learning is an important aspect of modern intelligence technology, which begins with the study of finding patterns in observed data samples and using these patterns to predict future or unobservable data [12].

The SVM method is a specialized method to achieve the structural risk minimization criterion, which has the advantages of global optimality, simple structure, and high generalization ability, and has been widely studied in recent years [13]. At present, the fugacity of coal ash is controlled by local structures because the cause of explosion is unknown. Therefore, coal mines with different geological units currently exist in different regions or within the same region [14]. The traditional statistical study is an asymptotic theory in which the number of samples is infinite, but in practical problems, the number of samples is limited [15]. Therefore, some theoretically good learning methods may perform poorly in practical applications. Therefore, the SVM method can be used to conduct prediction studies of coal ash blast coal ash to determine the risk level of exploding coal ash and take action to prevent the disaster.

The innovations of this paper are.

(1) Basic research on domestic and international coal mine disasters and comprehensive research on the causal mechanisms and epidemiological evolution of major coal mine disasters using support vector mechanics in the context of continuous improvement. The construction of coal mine energy and momentum conservation prediction on sensitivity to coal ash blast model

(2) Study the explosion characteristics of coal ash with different degrees of denaturation and establish the relationship between coal quality index and coal ash blast characteristics according to the influence of coal quality on coal ash blast characteristics

(3) Applying SVM theory, an SVM identification system for coal mine sensitivity prediction is established for online prediction of whether coal ash will explode

The research framework of this paper consists of five parts, which are structured in detail as follows.

The first part of the paper introduces the background and significance of the study and describes the main tasks of the paper. The second part introduces the prediction on sensitivity to coal ash blast and related works related to the support vector mechanics technique. The third part summarizes the relationship between coal quality index and coal ash blast characteristics, establishes the SVM-based prediction on sensitivity to coal ash blast model, and gives a more comprehensive understanding of the idea of sensitivity prediction. The fourth part is the core of the paper, from the analysis of the construction of the sample data in SVM and the analysis of the learning training of SVM, to complete the description of the application of SVM in the prediction on sensitivity to coal ash blast. The last part of the paper is the summary of the work.

2. Related Work

2.1. Prediction on Sensitivity to Coal Ash Blast. Coal ash blast not only wastes resources but also burns equipment, affects production, and causes gas and coal ash blast, resulting in casualties. In recent years, the state has actively promoted coal ash prevention and control, established a coal ash prevention and control work system, increased investment in technological innovation in coal mine safety, and organized scientific and technological work. And despite the consistent results of national-focused coal ash remediation actions, coal mine accidents still pose a major threat to coal safety production in China. Therefore, coal ash accidents in mines are the great enemy of coal mine production and such accidents must be eliminated.

Shi et al. proposed that one of the important means to prevent dust explosion and reduce the risk of explosion is to master the explosive thermodynamic parameters and explosion mechanism model of such dust through theoretical analysis or experimental studies of explosion strength, maximum explosion pressure, and explosion [16]. Li et al. used fuzzy mathematical comprehensive evaluation technique to analyze and improve the coal ash blast criterion, and then the coal ash blast was analyzed and improved [17]. Szkudlarek and Janas studied the pressure and flame propagation velocity during detonation against an obstacle and found that the addition of an obstacle could increase the instantaneous velocity of the flame in front of the obstacle by up to 24 times compared to the unobstructed flame velocity [18]. The mechanism of explosion-induced coal ash blast was investigated experimentally and numerically by Ban et al. The rise of deposited coal ash due to external forces was simulated [19]. Tan et al. coal ash studied the effect of obstacles on flame propagation patterns in explosions and found that the flame propagation velocity increased significantly with the increase in the number of obstacles [20].

According to China's current coal ash control capability and technical level, it should realize modern management, manage coal ash in mines by scientific methods, and make scientific prediction of coal ash disaster in mines, so as to grasp the dynamics of coal ash in mines, correctly identify coal ash blast or not, and propose anti-disaster countermeasures in time.

2.2. Support Vector Machine Technology. Although SVMs have been proposed for many years, they have matured to develop very rapidly and have been evaluated more widely, especially in applied research. SVM-based prediction on sensitivity to coal ash blast can provide dynamic information on environmental safety parameters for production managers and business units at all levels. The comparative analysis of the measured parameters provides data for disaster and accident prevention. Therefore, it will be of great practical importance for accident prevention and mine production if continuous and accurate advance prediction of coal ash can be made by using SVM.

Sumaya et al. applied the classification method of SVM to prediction on sensitivity to coal ash blast and showed by

the results that the SVM-based prediction on sensitivity to coal ash blast method has high accuracy and the method is scientifically feasible and has wide application prospects [21]. Liu et al. proposed a chunking algorithm to solve the large training sample SVM problem, and the chunking algorithm is efficient when the number of support vectors is much smaller than the number of training samples, but the algorithm is still complex when the number of support vectors is large [22]. Luo et al. mathematically calculated the deformability of the coal seam, the kinetic energy of the surrounding rock, the expansion effect of the explosion sensitivity, and the work required to cause coal ash based on laboratory simulations. However, it is not yet possible to explain the asymptotic damage process and damage conditions of coal-bearing explosions [23]. Harris and Sapko proposed a training algorithm for SVM called sequence minimization, which is a special case of decomposition methods [24]. Qian et al. argued that fuzzy mathematical theory is an important tool for representing and dealing with imprecise data and conditions of fuzzy information. Incremental training consists of SVM and new samples, and all unsupported vectors are discarded [25].

SVM is the most successful implementation of statistical learning theory to date and is still under development. Therefore, the use of SVM to establish a sound and reasonable index system for coal ash prediction and to improve the accuracy of coal ash blast prediction is an urgent problem for mines to solve.

3. SVM-Based Prediction on Sensitivity to Coal Ash Blast with Different Deterioration Degree

3.1. Relationship between Coal Quality Index and Coal Ash Blast Characteristics. Coal ash blast intensity characteristics mainly include flame, pressure, temperature, and impact airflow properties [26]. Since coal ash blast intensity characteristics are influenced by different factors, in many cases, changes in certain factors can greatly affect the blast intensity and even change the nature of the blast [27]. In a discrete time signal, if two very close samples have different algebraic signs, they are called over-zero:

$$Z_n = \sum |\text{sgn}\,[x(m)] - \text{sgn}\,[x(m-1)]|\, w(n-m), \quad (1)$$

sgn []—take symbols
m—window starting point
w(n)—window function
Get the corresponding decision function, namely, SVM:

$$f(x) = \text{sgn}\left[\sum_{i=1}^{s} y_i \alpha_i^{*} K(x_i \cdot x) + b^{*}\right]. \quad (2)$$

Define the risk of each time window as the standard deviation of logarithmic rate of return, namely:

$$S = \sqrt{\frac{1}{n\text{-}1}\sum_{j=1}^{n}\left(Z_{j\Delta t} - \bar{Z}\right)^2}, \quad (3)$$

$$\bar{Z} = \frac{1}{n}\sum_{j=1}^{n} Z_{j\Delta t}. \quad (4)$$

By solving the control equations of discrete phase and continuous phase alternately, the bi-directional coupling calculation of discrete phase and continuous phase is realized until both converge, as shown in Figure 1.

First of all, the pressure characteristics of coal ash blast are an important parameter to characterize the strength of coal ash blast [28]. The rheological properties of coal are prediction on sensitivity to coal ash blast that occur on the physical basis of the time lag, and its substance is just one of the three main factors in the occurrence of the explosion of the nature of coal. And some sampling algorithm is used to select the most favorable samples in the training sample set for the classifier performance, label its class, and add it to the initial training sample set and retrain the classifier. In this case, the computational complexity of the classifier is:

$$O\left(N_{sv}{}^2 + LN_{sv}{}^2 + dLN_{sv}\right), \quad (5)$$

L—scale of training sample set
d_i—enter the dimension of the sample
N_{sv}—number of support vectors
The minimum empirical risk is found in each subset, and then the subset that minimizes the sum of the minimum empirical risk and the confidence range is selected. However, this is more time-consuming, especially infeasible when the number of subsets is large or even infinite [29]. Therefore, for linearly divisible problems, we should choose a hyperplane that can completely and correctly partition the training set, which may lead to the nonexistence of a hyperplane for linearly indivisible problems. The location of the source of the explosion can be determined by technical means, and time sensors that can accurately measure the movement time of the object as well as flame sensors can be installed in the explosive section to obtain data on the farthest distance and propagation time of the flame propagation, which can be used for explosion energy estimation.

Secondly, due to the complex and variable environmental conditions and many influencing factors in underground coal mine operations, the variability of coal ash blast flame characteristics in its generation and propagation process is great under the interference of different factors. According to the law of mass conservation, the unidirectional flow of coal ash in nonhomogeneous coal seam has:

$$\frac{\partial P}{\partial t} + \frac{\partial q}{\partial x} = 0. \quad (6)$$

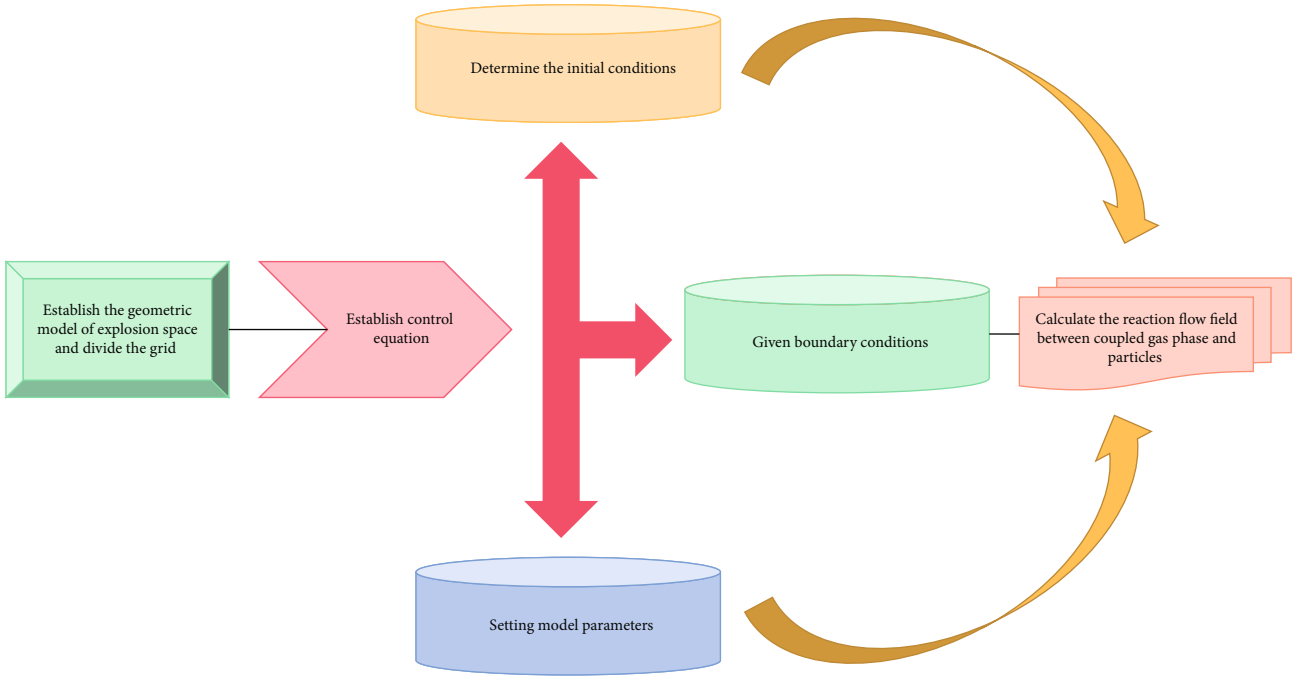

Figure 1: Coal ash blast simulation calculation flow.

So the coal ash emission calculation formula:

$$q = -\lambda \frac{\partial P'}{dx}, \tag{7}$$

P'—coal ash pressure

The explosion destabilization theory considering time effects illustrates that destabilization damage of the system can occur only when creep causes the system to become unstable under certain stresses and pore coal ash pressure, i.e., explosion occurs. The training is performed using samples to determine the specific parameters of the SVM classification identifier. The SVM prediction system is shown in Figure 2.

Design a certain structure of the function set so that each subset can obtain the minimum empirical risk, and then only need to choose the appropriate subset so that the confidence range is minimum, then the subset so that the function of the minimum empirical risk is the optimal function. Due to the complex and changing environmental conditions of underground coal mine operations and the influence of many factors, so in the interference of different factors, coal ash blast flame characteristics in its generation and propagation process are of great variability. As long as the explosion trace identification is to determine the farthest distance of the flame propagation, you can deduce the explosion experience time, and then substituted into the energy prediction model can also be derived from the results.

Finally, in the maximum pressure of coal ash blast in the near spherical space, the maximum pressure rise rate and the characteristics of the flame peak in the horizontal pipe space are combined with the complex and variable characteristics of the influence of coal ash blast. In full use of the experimental device on the basis of short experimental cycle and easy to repeat the advantages of the analysis of different test parameters on the impact of explosion strength characteristics. The occurrence of explosive hazards is extremely irregular, the system in which they are located is a constantly changing system, a variety of mechanical effects with the geological body is formed by these effects, and most are in a complex nonlinear state. In order to ensure safety, the emphasis is on predicting nonexplosive to complete accuracy, so the critical value of the explosion is set relatively low, the result of many nonexplosive hazard sites. Due to the need to use a uniform critical value, it is considered to be an explosion hazard, and explosion-proof measures must be taken. At the same time, make the calculation process greatly simplified, eliminating the previous complex partial differential equation of the arithmetic process and reducing the high requirements for mastery of mathematical theory in the model solution.

3.2. Establishment of Prediction on Sensitivity to Coal Ash Blast Model Based on SVM. Prediction on sensitivity to coal ash blast not only can guide the scientific application of explosion-proof measures and reduce the amount of explosion-proof measure works but also ensure the personal safety of coal seam operators due to the uninterrupted inspection of the explosion hazard at the working face [30]. Therefore, the establishment of SVM-based prediction on sensitivity to coal ash blast model is particularly important.

First, the blast moment and stress drop are measured by the microburst monitoring system for the original data, after the software preprocessing and saved. Each day can be measured in multiple sets of blast moment and stress drop

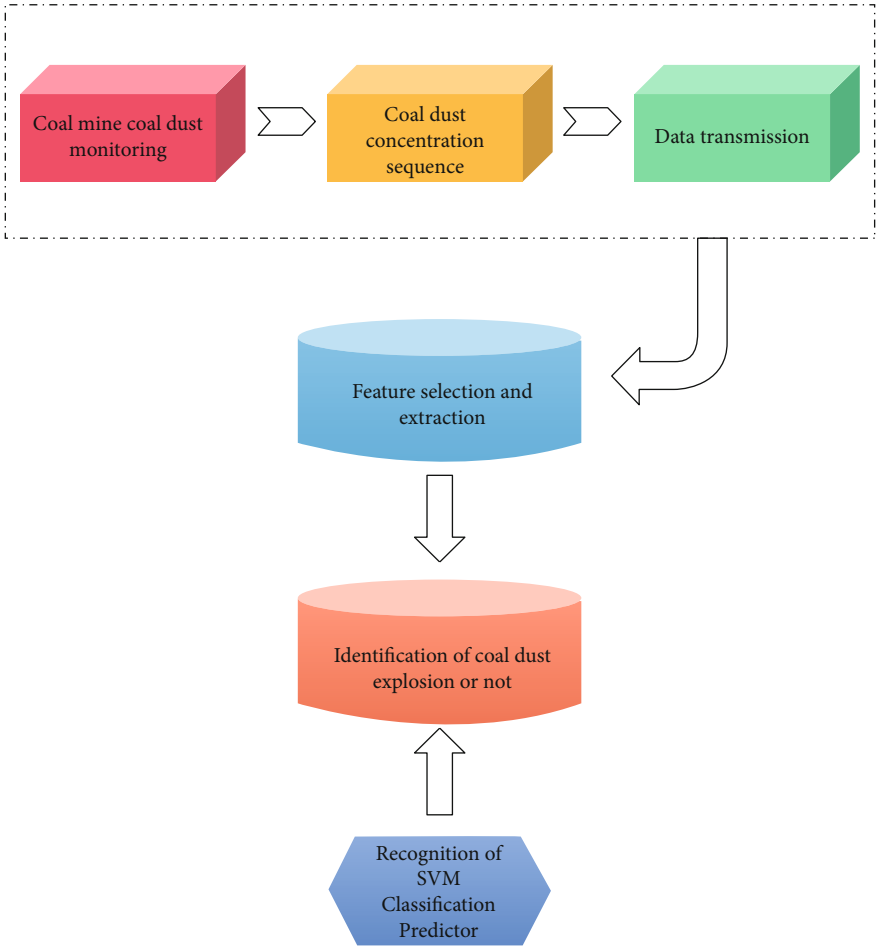

Figure 2: SVM prediction system.

values, by taking the average value of a value as a representative of the day. The SVM algorithm is shown in Figure 3.

Once the parameters are determined, they are not modified in subsequent SVM constructions. The simplest method of parameter selection is to define a training set, a confirmation set, and a test set. Then, several different sets of parameters are selected, and the support vector values are introduced from the training data in the training set, and the set of parameters that minimizes the data errors in the confirmation set is selected as the model parameters. For this purpose, pre-weighting is performed in preprocessing. For all functions in the indicator function set, the probability between the empirical risk and the actual risk satisfies:

$$R(w) \leq \operatorname{Re} mp(w) + \sqrt{\frac{h \ln (2l/h + 1) - \ln h/4}{l}}, \quad (8)$$

h—dimension of function set

n—sample number

Coal ash desorption in coal mines is a long process, while the explosion process is a fast-moving process. Small explosions last only a few seconds, and large explosions last only a few tens of seconds, and the time for coal ash desorption during the explosion may be only milliseconds, relying on the energy of the coal ash desorbed during this time to throw the coal ash mass from its original location into the roadway space. The prediction objective is based on the purpose of this paper, i.e., to predict the propensity of coal ash blast, and the parameter that can quantitatively assess the propensity of coal ash blast, i.e., the cumulative energy release rate, is chosen as the target vector. By using the squared term as the optimization index, only the equation is constrained, so that the initial problem is no longer a quadratic programming solution, and can be expressed as:

$$\min \frac{1}{2}\|w\|^2 + \frac{1}{2} r \sum_{i=1}^{l} \xi_i^2, \quad (9)$$

r—error penalty component

Secondly, the corresponding SVM program was prepared, and the corresponding prediction model of coal dust explosion propensity was established, using a large number of example data as training samples and prediction samples. Then, an error rate was obtained for each test set, and finally

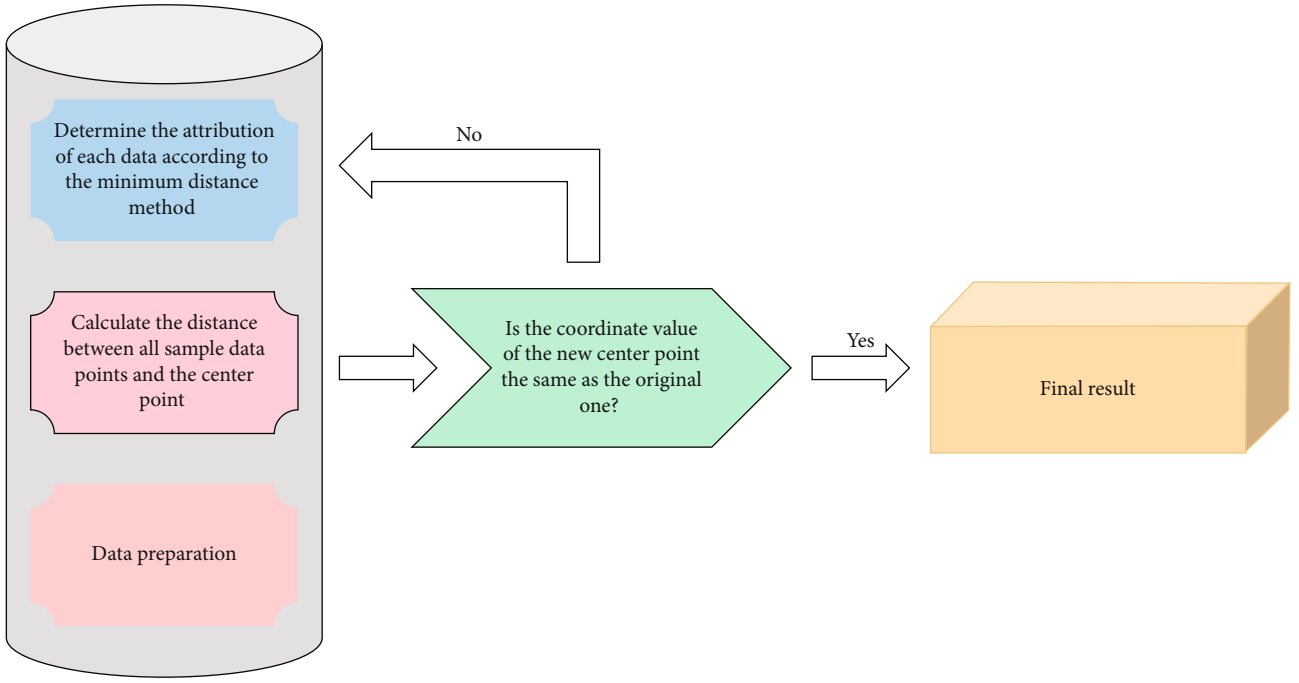

Figure 3: SVM algorithm.

the average of all error rates was taken as the final error rate. The ground stress and coal ash pressure values within the unloading zone are both greatly reduced from their original values; the ground stress within the concentrated stress zone is higher than the original value, and the coal seam permeability is sharply reduced to prevent the discharge of coal ash, so the high coal ash pressure gradient and gas pressure values are maintained. The rock structure, when receiving external stresses, causes different dynamic phenomena and elastic waves in the coal mine due to inelastic deformation and structural nonstability. In the absence of any information at all, this discretized probability distribution should satisfy the following "maximum entropy" problem:

$$\max H(\lambda) = -\sum_{i=1}^{m} \lambda_i \ln \lambda_i, \tag{10}$$

$H(\lambda)$_Shannon entropy

Since the shape and frequency spectrum of the stress waves emitted from the coal mine at different deformation stages are different, and the generation of coal ash blast requires a certain amount of energy, there will be a period of energy accumulation before the occurrence of coal ash blast, i.e., a period of smoothness. Then, we estimate the upper limit of the error rate by using the result obtained, and then adjust the parameters of the kernel function by using the gradient descent method for the upper limit of the error rate, and repeat the above steps until we get the minimum upper limit of the error rate. The method of converting analog signals to digital signals is based on regularization theory. The regularization problem can be obtained in the following form:

$$\min \frac{1}{l}\sum_{i=1}^{l} V\left(y_i, f(x_i) + \lambda \|f\|_K^2\right), \tag{11}$$

λ_regularization factor

$\|f\|_K^2$_reproducing kernel Hilbert space

V_loss function

Finally, we train the classifier with the normalized training data to obtain the diagnostic model and then use the model to test on the test set. The maximum and minimum values of the parameters to be selected are set, and the jump step is also set for each parameter. Then, the parameters are combined by the jump step separately, and finally the combination with the highest accuracy is found by validation. In particular, as the mining depth increases, the coal ash pressure and ground stress increase, and the corresponding gas internal energy and deformation potential of coal seam also grow. It causes more and more coal ash containing coal rock explosion induced disasters; prediction on sensitivity to coal ash blast and prevention work are more and more difficult. Thus, for linear systems, when the estimated model order is the same as the actual model order, the accuracy of identification is high, and vice versa, the accuracy of identification is reduced. For the nonlinear system, the accuracy of identification is related to the complexity of the kernel function, and the accuracy decreases with the increase of the complexity of the kernel function.

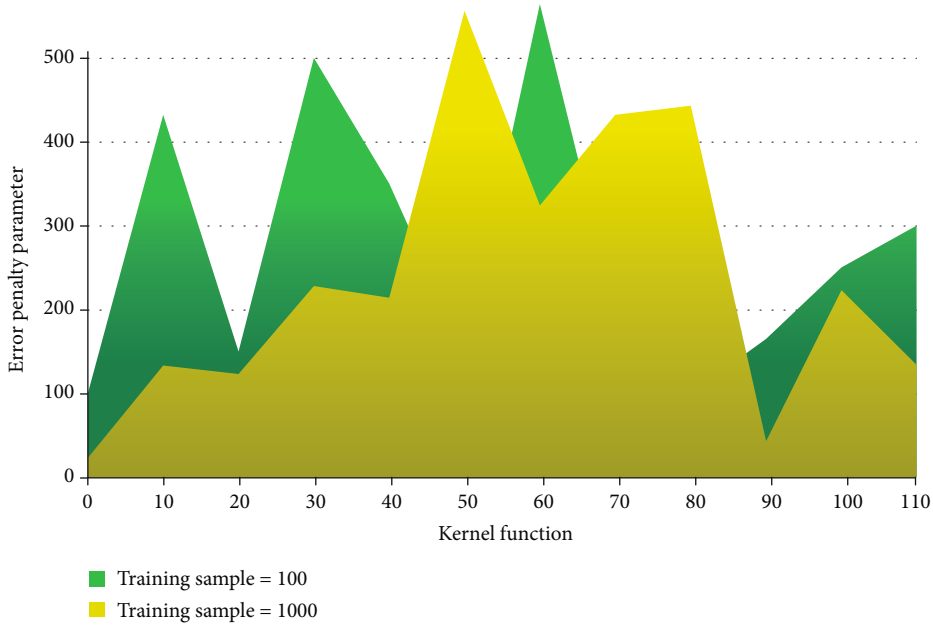

Figure 4: Changes of SVM performance with kernel parameters.

4. Application Analysis of SVM in Prediction on Sensitivity to Coal Ash Blast

4.1. Construction and Analysis of Sample Data in SVM. Different SVM models are handled in different ways. The sample data regulate the maximum step size of the flight direction of the global optimal particle and the individual best particle, respectively; if it is too large, it will lead to a sudden flight towards or over the target region; if it is too small, the particles are likely to be far away from the target region. If it is possible to predict continuously whether an explosion occurs in a coal mine or not based on the sample data of previous explosion events in that mine, this is the research of this chapter.

First, the factors affecting the predicted values are grouped into three main indicators: effective base concentration, sulfation, and factor. For a given sample point that cannot be separated or approximated by a hyperplane, a transformation can be used to map it to a space of higher dimensionality in order to improve the classification accuracy. In the following, a prediction on sensitivity to coal ash blast with 100 training samples and 1000 test samples is used in a one-to-many training mode to find the variation of the performance of Gaussian kernel SVM with kernel parameters and error penalty parameters. The results are shown in Figures 4 and 5.

Fault is also an important factor affecting the explosion, especially near the inverse fault. This is due to the strong extrusion of the reverse fault, fault near the structure of coal is generally very developed, and this strong structural damage to the coal permeability is very poor, often become an important barrier to prevent the transport of coal ash. Different degrees of coal ash volatile fraction of different degrees of metamorphosis, the material composition of the coal quality between the large differences, different degrees of coal ash reaction reducing agent content has a large difference, resulting in a large difference in the maximum pressure of the explosion. And coal ash concentration is low, coal ash particles are less, the particle spacing is relatively large, the particles absorb heat transfer, and reaction time will increase, resulting in the total duration of combustion also increased.

Secondly, in order to eliminate the influence of each factor due to different magnitudes and units, the input and output parameters of the samples are normalized separately. A part of the samples is selected to form the working sample set for training, the nonsupport vectors are removed, and the training results are used to test the remaining samples. The samples that do not meet the training results are generally those that violate the conditions or some of them are combined with the support vectors of this result into a new working sample set and then retrained. Assuming that all categories contain the same number of samples, the core of the algorithm complexity is still the solution of the constraint extreme value problem. The performance comparison of different multi-classification prediction methods is shown in Table 1.

However, in the geological structure complex area or the tunnel will be through the section, this cycle is often broken, resulting in the superposition of the coal body stress in front of the workings. The coal ash concentration where the maximum value of coal ash blast pressure and the minimum value of burning duration are located is different for different degrees of metamorphism. Therefore, coal samples should be taken downhole and adsorption experiments should be carried out in the laboratory to determine coal ash basic parameters such as coal to coal ash adsorption constants, moisture, and ash content at constant temperature. The coal seam coal ash content is then calculated from the measured original coal ash pressure of the coal seam.

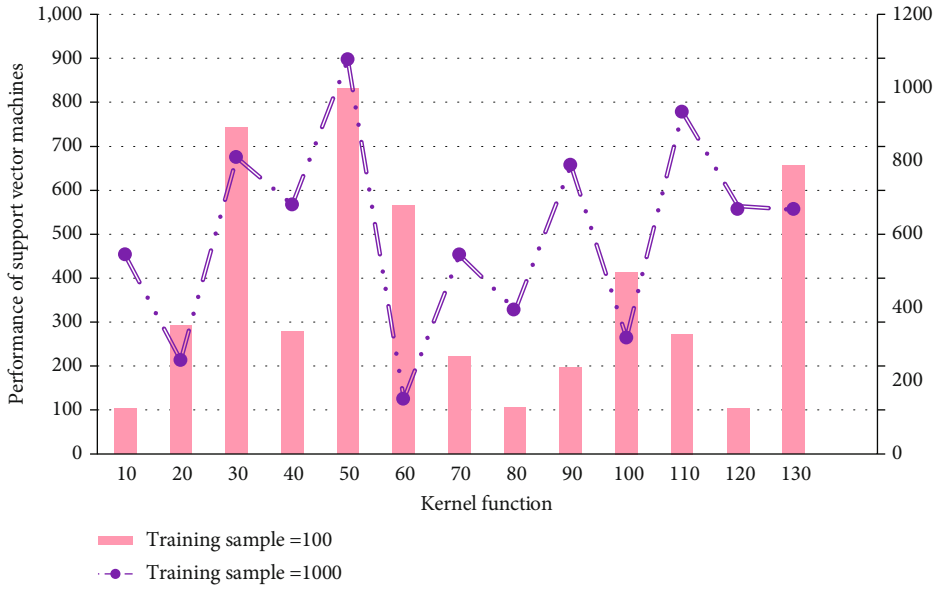

Figure 5: Changes of SVM performance with error penalty parameters.

Table 1: Performance comparison of different multi-classification forecasting methods.

Multiple classification method	One-to-one	One-to-many	Global optimization
Error rate	34.3	39.1	44.6
Total number of support vectors	32	44	36
Training time	65	78	93
Average sum function budget times	17	23	41

Finally, by mapping the data into the feature space and trying to describe the data in the feature space with a hypersphere, the majority of the data is to be included in this hypersphere. The size of the working sample set is fixed within the tolerable limit of the algorithm speed, and the iterative process only swaps some of the worst-case samples from the remaining samples with the samples in the working sample set in equal amounts. Even if the number of mathematical models and algorithms studied in support vector data mining exceeds the size of the working sample set, the size of the working sample set is not changed, and only a part of the support vector is optimized. With the increase of coal seam burial depth, the thickness of overburden rock on coal seam gradually increases, and the ground stress increases accordingly; with the increase of coal seam burial depth, the permeability of coal seam and surrounding rock will decrease, and the distance of coal ash transport to the surface increases, which is favorable to the coal ash fugacity. Close to the optimal concentration of coal ash blast, the maximum explosion pressure is also larger, indicating that the coal ash close to the optimal coal ash blast concentration has a higher risk, in the actual production of coal ash concentration should be strictly controlled.

4.2. Analysis of Learning and Training Based on SVM. The learning training of SVM adopts training sample sequence input method instead of batch input method, which has the advantages of generating fewer SVMs and strong generalization performance. The increase in stress causes the electron clouds between molecules to overlap, the mobility of electrons between molecules increases, and the electron conductivity increases. Therefore, it is not possible to say qualitatively whether the electrical conductivity of coal increases or decreases when it is subjected to stress, but it is necessary to conduct specific experimental analysis for specific coal samples.

First, the samples are sequentially fed into the SVM algorithm in a sequential manner, and a forecast model containing a support vector is obtained after training. In the optimization problem description, different penalty coefficients are applied to each sampling point data to obtain more accurate classification. The plot of the simple step response SVM algorithm using simulation, compared with the Apriori algorithm, is shown in Figure 6.

While the optimization variables of the fixed working sample set method contain only working samples, the objective function contains the whole training sample set, i.e., the multipliers of the samples outside the working sample set are fixed as the results of the previous iteration. Instead of being set to two as in the block algorithm, the fixed working sample set method also involves a problem of determining the change-out samples. With the increase of ignition energy,

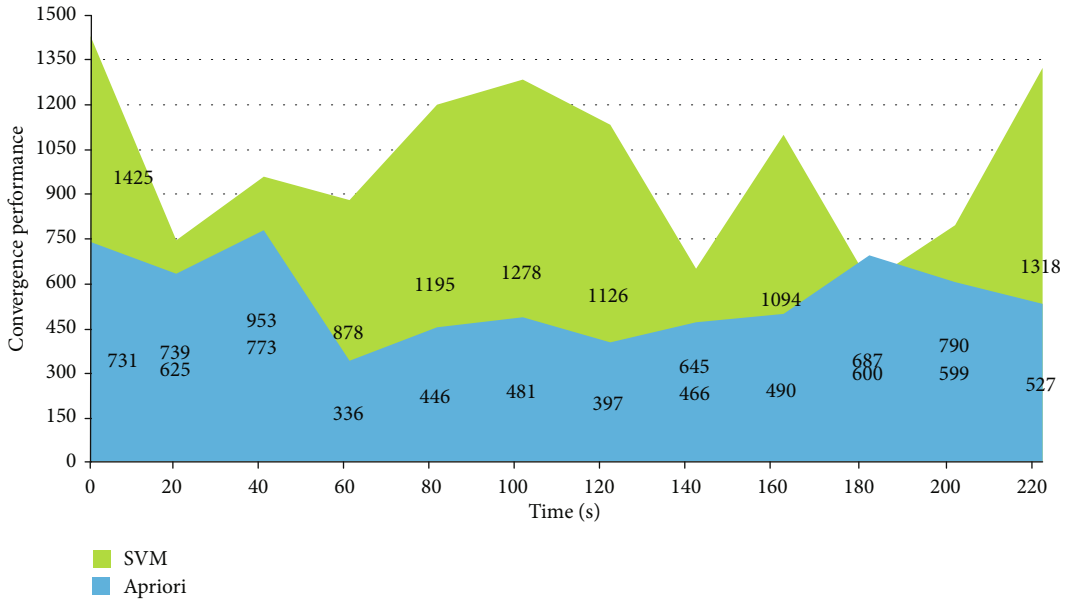

Figure 6: Convergence comparison.

Table 2: Prediction accuracy of three algorithms.

		SVM	BP neural network	Apriori
Positive category	Test data	76.5%	56.7%	49.5%
	Training data	98.5%	66.1%	34.6%
Negative category	Test data	87.1%	78.3%	63.1%
	Training data	93.4%	94.6%	87.1%

the maximum pressure of different degrees of deterioration coal ash blast is generally on the rise and the overall duration of combustion is on the decline. Since each coal ash particle is subjected to different magnitude and direction of force, these particles are in a chaotic turbulent state after mixing with the gas. The prediction accuracies of the three algorithms for each category are shown in Table 2.

From Table 2, the prediction accuracy of SVM on positive and negative categories improved by 15.6% over BP neural network and 35.1% over Apriori algorithm. Thus, the predictive effectiveness of the SVM algorithm was proved.

Secondly, the data input is limited by the moving window method, i.e., the size of the training samples. The nearest data are taken as the training set in turn. In the sample space or feature space, the optimal hyperplane is constructed to maximize the distance between the hyperplane and the different classes of the sample set, so as to achieve the maximum generalization ability. Since there are only two variables, and one can be expressed in terms of the other by applying the equation constraint, the optimal solution of the subproblem at each step of the iterative process can be found directly by analytical methods. After the coal ash particles are lifted up, coupled with the sweeping of the shock wave, the internal energy of the coal ash particles increases, the temperature rises, and some combustible gases are decomposed by heat, which are ignited and oxidized resulting in the ignition of the coal ash cloud to participate in the explosion. Since the number of training samples and test samples are small, the test error can be regarded as a reflection of the true generalization ability of the SVM. Figures 7 and 8 show the training error and test error of the SVM with the kernel and penalty parameters, respectively.

With the increase of ignition energy, the ambient temperature and volatile precipitation are increased, the effective ignition volume is increased, and the turbulence induced by high ignition energy can enhance the combustion efficiency. The air volume required at the coal mining face and the rated air volume of the local ventilation fan. The so-called optimal ventilation refers to seeking the minimum ventilation of the mine while ensuring that the coal ash concentration and coal ash concentration in each working face and return airway are not exceeded, forming an optimization problem with the goal of minimizing the total ventilation.

Finally, several free parameters in the model, including the bandwidth of the Gaussian basis kernel function, the regularization factor that balances the complexity and accuracy of the model, and the effect of the magnitude of the error coefficient on the generalization ability and complexity of the model prediction referring to the number of generated SVMs, are to be examined. In this way, a judgment function can be established, and for new sample points, if the function is calculated to be positive, it is a normal sample; otherwise, it is a singular point. There are differences in the content of volatile matter precipitated from coal ash with different degrees of deterioration at the same ignition energy, resulting in different corresponding maximum explosion pressures and burning durations. When a new individual sample appears, how it relates to the original sample set or

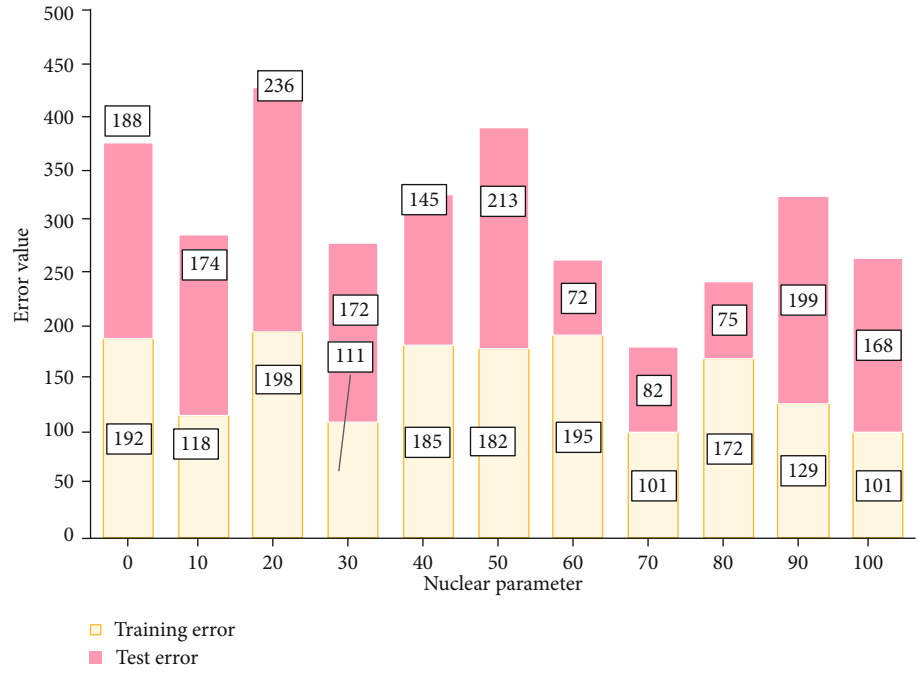

Figure 7: Training error and testing error of SVM under different kernel parameters.

Figure 8: Training error and testing error of SVM under different penalty parameters.

its subset, or to the training results of the original sample set, e.g., what effect its addition has on the support vector set of the original sample set, how to quickly determine the contribution of bamboo to the new classifier function, etc.

5. Conclusions

The continuous development of communication technology, automation technology, and artificial intelligence technology has led to great progress in the research of coal ash blast sensitivity prediction technology. Coal ash blast is a major hidden danger for coal mine safety in China, and the prediction and prevention of explosion accidents in mines play a very important role in ensuring the safety of mines. Sensitivity forecasting is the core technology of coal mine excavation and mining, and the reliability of its sensitivity forecasting is related to the economic benefits of coal mines and the lives and health of workers. For this reason, carrying out coal ash

blast sensitivity forecasting and establishing a reasonable coal ash blast sensitivity forecasting system can effectively carry out coal ash blast disaster prevention and control and reduce disaster losses. SVM regression is a new theory and method, which has many issues worth further research in both training algorithms and practical applications. Due to its unparalleled advantages in many traditional machine learning algorithms, it has become a popular research direction in the world at present and has been successfully applied in many aspects. SVM is used for natural fire prediction of coal seams, and the rationality and scientific validity of the method are verified through experiments. According to the prediction of different metamorphic degree coal ash blast sensitivity of SVM, a stable and high safety factor anti-seismic equipment can be designed according to the special situation of the mine, so as to reduce the danger caused by explosion.

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

Acknowledgments

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Retraction

Retracted: Abnormal Concentration Detection Method of Chemical Pollutants Based on Multisensor Fusion

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] W. Song, "Abnormal Concentration Detection Method of Chemical Pollutants Based on Multisensor Fusion," *Journal of Sensors*, vol. 2022, Article ID 2936960, 10 pages, 2022.

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Research Article

Abnormal Concentration Detection Method of Chemical Pollutants Based on Multisensor Fusion

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China is a big industrial producer, but also a big producer and user of chemical materials. Although the use of chemical materials has improved the level of industrialization, it has also caused harm to the environment and ecosystem. With the acceleration of China's industrialization, more and more attention has been paid to the problem of chemical pollution. The pollution of water resources in China has seriously damaged the balance of ecological environment and is also an important factor threatening people's own health. The detection of chemical pollutants in water resources, especially organic pollutants, has a long way to go. To solve this problem, this paper designs a method of chemical pollutant concentration detection based on multisource information fusion and analyzes the performance of the detection system. Firstly, this paper introduces the main types of situations of chemical pollution at present. Secondly, a multisensor fusion model based on BP neural network is established, and the collected chemical pollutant samples were input into the model. Finally, the quantitative and qualitative analysis of the detected pollutant concentration results shows that the proposed method not only has good detection effect of chemical pollutant concentration but also has good practicability. In a word, the proposed method not only has good theoretical significance but also has certain potential application value.

1. Introduction

Industrial development not only brings convenience to production and life but also brings great disadvantages. A large number of organic chemical pollutants are discharged into the water body, many of which have complex structures and are difficult to degrade and have caused serious impacts on the water environment after accumulation [1, 2]. In the face of more and more serious situation of environmental pollution, prevention and control from the source are particularly important. Sensing technology is a new analysis technology derived from electrochemical analysis. It uses the interaction between the detected substance and the modified photoactive substance to observe the signal changes of photocurrent or photovoltage before and after the identification process of biomolecules to determine the concentration of the substance to be detected. The method has the advantages of low cost and easy operation. However, due to the use of some of the more precise electrochemical instruments, most of the detection still needs to be carried out in the laboratory, which is difficult to achieve real-time detection, which is not conducive to the wide application of environmental monitoring and detection [3].

China's highly developed urbanization and industrialization have provided people with richer material enjoyment. The vigorous development of economy has been accompanied by more and more serious environmental pollution, among which chemical pollution is the most serious. In recent years, China's water bodies have suffered from serious chemical pollution. The main ways of pollution are illegal discharge of industrial waste water, unreasonable disposal of urban sewage, and nonstandard chemical use. As China's sewage treatment capacity only accounts for about 20% of the total sewage, 70-80% of sewage (about 30 billion tons) is discharged directly without treatment. According to the statistics of water resources in China's major cities, their groundwater shows different levels of chemical pollution. Half of the contaminated sections are in the country's seven major river systems, 45 of the country's 78 major rivers. The Yellow, Huaihe, Taihu, Liaohe, Chaohu, and Dianchi rivers

account for 86% of the total number of rivers and lakes in urban areas. The specific chemical pollution is shown in Figure 1. In China, water containing bitter alkali, arsenic, fluoride, and industrial pollution is drunk by up to 65 percent of the population. According to the current statistics, organic chemicals and metals are the main types of water pollutants, the total number of pollutants has reached more than 2000 kinds, and there are 765 kinds of pollutants in the general urban tap water. There are many kinds of water pollutants in China, mainly organic pollution [4, 5].

In the environment, many pollutants are characterized by low water solubility and long degradation time. They can also influence the regional and even global environment through evaporation and condensation through the transport of water and atmosphere. These highly toxic organic pollutants tend to accumulate in the food chain. This type of organic pollutant is called persistent organic pollutants (POPs). The main feature of POPs is that it is difficult to degrade and toxic to bioaccumulate for a long time. POPs can accumulate in entire ecosystems around the globe, and this international migration is mainly through the movement and crossing of species, air, and water. As a result of migration, POPs accumulate in ecosystems far from where they are released and are deposited in areas there. Heavy metals, acid chemicals, and other pollutants have far less harm and impact on the environment than POPs. Carcinogenesis, neurotoxicity, reproductive toxicity endocrine disruption, genetic toxicity, and so on are persistent organic pollutants which can cause harm; medical research has proved that this is a lasting harm over a long period of time. In humans, fertility declines and cancer risk rises sharply. POPs can cause congenital dementia in fetuses and infants, as well as increased rates of stunting and malformation. The reproductive organs that appear in some fish remain underdeveloped. Many animals are found to have male degeneration and high rates of hermaphroditism. POPs with migration and globalization can cause damage to ecological environment, pollution of water resources, and harm to human health [6, 7].

The organic pollution in water can be divided into two kinds according to its source. One is the natural organic matter in the natural ecological environment. Most of this kind of organic matter comes from organisms, such as the matter generated after the death and decay of organisms, metabolites produced by microorganisms, and metabolites produced by animals. The other is synthetic organics, which are mostly man-made chemicals. These include pesticides used in agriculture, synthetic products for commercial use such as pharmaceuticals, plastics, and industrial waste. However, organic matter is a kind of organic matter synthesized by the natural organism, which is transferred to the natural environment in the process of biological metabolism. The natural organic matter in water is not only produced by the metabolism of bacteria, algae, and aquatic plants existing in water but also by metabolic products from terrestrial organisms. Due to the interaction between the natural water cycle and the ecosphere, there are a large number of natural organic compounds from the ecosphere gathered in the natural water system, among which the humus content in the surface water source after the death of organisms accounts for the highest proportion compared with other organic compounds. There are two types of natural organic matter in water; they are divided into hydrophilic organic matter and hydrophobic organic matter. Hydrophobic organics mainly contain aromatic carbon in structure and have phenolic structure and conjugated double bond. Hydrophilic organics are structurally rich in a higher proportion of aliphatic carbon and nitrogen compounds. The complex natural organic matrix may not only change with the change of natural ecological environment but also some organic compounds may react with each other and become more complex. If the natural organic matter in water is too rich, it will not only have a serious impact on domestic water but also its complex enrichment degree will have a great impact on the selection, design, and operation of water treatment process. Of course, the natural organic matter with corrosive effect will also cause difficulties in the operation of industrial facilities [8, 9].

With the development of industrialization, more than 10 million kinds of organic chemical pollutants have been discovered and synthesized artificially. There are a variety of such organisms that enter the environment through various channels. Synthetic organic pollutants often come from light industry, chemicals, and emerging industries such as pharmaceuticals, including pesticides, phenols, and cyanide commonly used in agriculture. Common detergents and residues in all kinds of food synthetic antibiotics and so on. Due to the complex structure, these pollutants are difficult to degrade in the natural environment, resulting in the accumulation of pollutants in the environment, causing great harm to organisms and the environment.

Pesticides mainly refer to chemicals used to control pests in water production and regulate plant growth [10, 11]. In the development of modern society, the use of chemical products has become the most common prevention and control measures because of its advantages of fast, effective, and low cost. According to statistics, the use of chemicals around the world can reduce the losses of various industries by about 30%, thus greatly improving the economic benefits of the society. China is a big industrial country and also a big country in the production and use of chemical products. The wide use of all kinds of chemical pesticides has made great contributions to the development of society and is also an important means to improve economic benefits. According to the statistics of relevant departments, it is estimated that the money spent on the use of chemicals can get four times the profit; it can be seen that chemicals are the most important means of production to ensure the stable production of the industry and the weight of profit. Many industrial production systems now rely on the widespread use of pesticides and other chemicals. Due to the lag of plant protection machinery and application technology in China, most of the chemical drugs are scattered in the soil or floating in the air and other surrounding environment in the process of spraying, while a small part is attached to the leaves of crops. If the concentration of spraying chemicals is too small to effectively kill pests and diseases, but the concentration of spraying chemicals is too large, it will not only produce

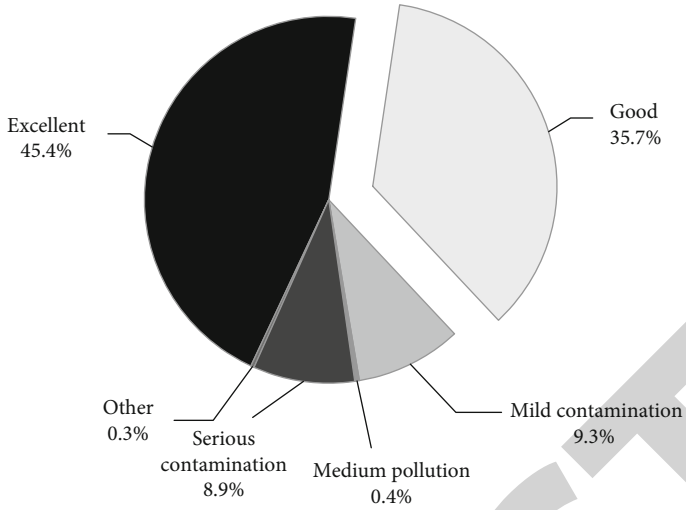

Figure 1: The proportion of different chemical pollutants.

pesticide harm to crops but also pollute the environment and even threaten human health. Therefore, in order to manage chemicals properly, governments have formulated relevant policies to guide the use of chemicals, established appropriate chemical management systems, and determined the maximum concentration of spraying in actual field spraying. Therefore, strengthening the analysis and detection of chemical pollutant concentration is an urgent need to improve economic benefits and protect the ecosystem and human health from possible harm [12, 13].

2. Related Work

The internationally accepted standard method of organic pollutants in water is to roughly predict the pollution level of organic matter in water by analyzing chemical oxygen demand (COD), so as to estimate the degree of chemical oxidation of pollutants in water. Due to the high relative accuracy of COD standard method, environmental supervision departments of various countries have formulated a series of water quality monitoring indicators according to COD standard method. The standard of drinking water in China clearly stipulates that the COD of class I and II water is less than 15 mg/L, the COD of class III water is less than 20 mg/L, the COD of class IV water is less than 30 mg/L, and the COD of class V water is less than 40 mg/L. In addition to these standard methods, some researchers have also proposed the advantages of alkaline potassium permanganate and acid potassium dichromate methods to design a new digestion mode for treating water samples and successfully established a feasible potentiometric titration method. This method can realize the detection of low COD value in daily drinking water. This method has high degradation efficiency, good precision, and low detection limit. Compared with the standard method, this detection method has higher accuracy in the detection of low concentration [14, 15]. Because the single organic pollutants in water generally exist in a small amount in the water environment, it leads to the use of conventional standard indicators such as COD detection which cannot determine the accurate content. Therefore, in the face of some serious chemical pollutants, the country has formulated the corresponding standard for the detection of single organic matter, and many methods for the detection of such substances have emerged. Over the past few decades, a number of techniques have been developed for the determination of contamination concentrations in samples, including conventional detection methods and new types of conventional biosensor analysis methods, which have been effectively applied to the detection of chemical contaminant concentrations. The following focuses on several typical methods for detecting single organic contaminants.

Gas chromatography refers to the chromatography using gas as the mobile phase. Due to the rapid transfer of the sample through the gas phase, the sample components can reach an instant equilibrium between the mobile phase and the stationary phase. In addition, there are many substances that can be selected as stationary phase, so gas chromatography is a separation and analysis method with high analysis speed and high separation efficiency. The experimental results show that this method can reliably detect low concentration of pollutants in strawberry jam, and the detection method has good reproducibility and selectivity. Liquid chromatography is a kind of separation and analysis technology, which is characterized by liquid as mobile phase; stationary phase can be a variety of forms, such as paper, sheet, and packed bed. In pesticide analysis, liquid chromatography is usually combined with UV detection, fluorescence detector, and other techniques. Liquid chromatography has high sensitivity and selectivity [16, 17]. Mass spectrometry is a method that separates moving ions according to their mass to charge ratio by electric field and magnetic field. The composition of ionic compounds can be determined by measuring the exact mass of ions. Mass spectrometry combined with probe sampling has emerged as a new and efficient analytical tool to provide important toxicological information and ensure an appropriate emergency response.

Spectral analysis is a method to identify substances and determine their chemical composition and relative content according to their spectra. It is an analytical method based on molecular and atomic spectroscopy. Electrochemical analysis is a kind of instrumental analysis method based on the electrochemical properties of substances in solution. A method for the determination of a test fluid as a component of a chemical cell based on the relationship between some electrical parameters of the cell (such as resistance, conductance, current, or voltage) and the concentration of the substance to be measured. Microbial analysis and detection method is based on the principle of microbial biological activity to detect the degree of sensitivity; this method can be used to determine some inhibition of microbial growth of antibiotics, toxins, or chemicals and other organic pollutants [18, 19].

In a word, researchers in related fields have been extensively exploring the detection methods of pesticide concentration and achieved fruitful results. However, the detection methods based on chromatography and mass spectrometry are time-consuming and laborious. Spectroscopic analysis requires expensive instruments, time-consuming sample pretreatment, and specialized operators. The electrochemical sensor does not need biological active enzymes and antigen-labeled antibodies, and its operation interface is simple, showing the advantages of high sensitivity and fast in the analysis of trace pesticide concentration, but its application scope is narrow. Photochemistry, which evolved from electrochemistry, is a new discipline to explore the influence of light on photoactive substances. Photochemistry mainly refers to the conversion of light into electricity and the mutual conversion of electric energy and chemical energy. In the 1830s, Bechrer of France discovered that in the presence of light, the electrical signal of the metal electrode attached to silver halide in the electrolyte would change, so he proposed the Bechrer effect [20, 21]. Chemical sensor is a special kind of sensor in modern analytical chemistry. It is composed of induction device (recognition) and transducer (conversion), which is based on the electrochemical activity of the target detection object, through the electrochemical reaction of the target detection object on the induction element (electrode), so as to generate electrical signals. The perceived electrical signal is then recognized and converted and finally displayed on the computer. The response value of the generated electrical signal will increase with the increase of the concentration of the target detection object. The principle of the electrochemical sensor to detect pollutants is that the pollutants of a certain concentration are adsorbed at the electrode interface first, and redox reactions occur under pressurized electrocatalytic conditions. Since the essence of redox reaction is the gain and loss of electrons, the number of gained and lost electrons in the process of this chemical reaction can be accurately captured, macroscopically expressed as the size of current value. Therefore, a quantitative relationship is established between pollutant concentration and electrical signal. At the same time, the electrode can identify different pollutants qualitatively or quantitatively due to the different peak locations of different pollutants [22, 23].

Typical sensor systems are mostly composed of four parts, including xenon lamp as excitation light source system, electrolytic cell as reaction place, electrochemical workstation for collecting and processing electrical signals, and the most important three-electrode system. Analysis and detection substances can directly or indirectly change the properties of photosensitive materials or electrolyte environment, which will affect one of the above processes and then affect the signal generated in the whole PEC detection process. Therefore, in the process of photoelectric chemical analysis, quantitative analysis is generally achieved through the change of signal. Compared with traditional electrochemical sensing, PEC sensing technology combines the advantages of photochemistry and electrochemistry. PEC sensing technology detects signals and excitation signals in different energy forms, which ensures that the two signals are independent of each other and will not interfere in the analysis and detection. Unlike electrochemical sensing, which usually generates signals at specific potentials, PEC sensing reduces the dependence on applied potentials. In addition, compared with spectral detection techniques, which usually involve complex and expensive equipment, the electrical signal mode enables PEC sensing to have the characteristics of simple instrument, low cost, and easy miniaturization. In order to further simplify the PEC sensor system and improve its portability, some scholars have studied two new sensing technologies: self-powered photochemical sensor and photochromic visual sensor. Self-powered electrochemical sensor is a PFC sensing technology based on PEC sensing and combined with the characteristics of self-powered fuel cell, which can realize self-powered analysis and detection of detected objects. This kind of sensor construction method is different from the classical three-electrode electrochemical sensor driven by an external power supply. It adopts a two-electrode system. The other energy is converted into electricity through the reaction of both anode and cathode, so the whole sensing process does not need power supply. Photochromic visual sensor is a new sensing technology combining photochromic devices and photochemical sensors [24, 25]. It uses the characteristics of electrochromic devices that can produce different discoloration effects under different current signals to achieve the purpose of quantitative analysis of detected objects. This technique successfully simplifies the signal output of photoelectric chemical sensing technology from electrochemical workstation to color change.

Although the sensor technology mentioned above has made a lot of research achievements in the field of chemical pollutant concentration detection, these methods have their own limitations and there is no method to study the technology of multisensor fusion. Because multisensor is to fuse and enhance the data of multiple sensors, it can provide more useful information than a single sensor, thus improving the performance of the model. Therefore, in view of these problems, this paper is aimed at developing simple, fast, convenient modification and modification methods, low development cost. An easy and stable method was developed for rapid and sensitive detection of chemical pollutants in water environment. Based on the above discussions, the main contributions of this paper are shown as follows:

(1) This paper is the first time to apply the model based on multisensor to the detection of chemical pollutant concentration and has achieved good performance of the model

(2) The proposed method not only has certain theoretical value but also has wide application prospect

3. Multisensor Fusion-Based Abnormal Concentration Detection of Chemical Pollutants

3.1. Introduction of Multisensor Information Fusion. The concept of multisensor information fusion is derived from interconnection probability information filter to solve the problem of information synthesis in recognition technology. This information processing technology was first used in the military field and made outstanding contributions to the detection of enemy submarines at that time. With the rapid development of information technology, the application scope of multisensor information fusion technology also extends to many aspects of modern society; its emergence has promoted the rapid development of many scientific and engineering fields. The structure of multisensor information fusion can analyze series structure, parallel structure, and series and parallel structure. Here, we take the series-parallel structure as an example to illustrate, as shown in Figure 2. And the sensor is first input into the model. In this figure, one sensor corresponds to one model for simplicity.

This structure contains the characteristics of both serial and parallel structures, which can combine the advantages of the two structures into one system. The method of structure fusion is to locally model the information collected by each sensor. Then, the local modeling results are sent to the fusion center for fusion again, and finally, results are obtained. Its main responsibility is to accept the information data sent by the feature layer and find out the information directly related to the research object and the problem to be solved. According to the actual situation, the appropriate processing algorithm is used to comprehensively process the feature information, analyze, and conclude the final judgment result. Generally, the decision-making of the whole system is based on its results, which directly determines the reliability and effectiveness of the system.

3.2. Multisensor Fusion-Based BP Neural Network. Generally speaking, the overall structure of BP neural network can be divided into three layers: input layer, hidden layer, and output layer, which is given in Figure 3. The main function of input layer is to input the signal collected from the outside into the whole network for fusion calculation. The input of the multisensor fusion BP neural network is the concentration of chemical contaminants, sampling interval, adoption time, etc. The output layer and hidden layer of BP generally adopt tan and log functions as the activation functions to generate transformation. The advantage of using such activation functions is that these two functions are not linear functions but differentiable functions, and it is easy to obtain partial derivatives by using these two functions in calculation. The neuron nodes in the input layer of the characteristic layer receive the normalized data of temperature and pollutant concentration of the studied environment. Due to the data of pollutants we fused, these signal functions over time are continuous nonlinear functions, and the multilayer structure will only be used when fitting the noncontinuous function, so we adopt the structure of multihidden layers.

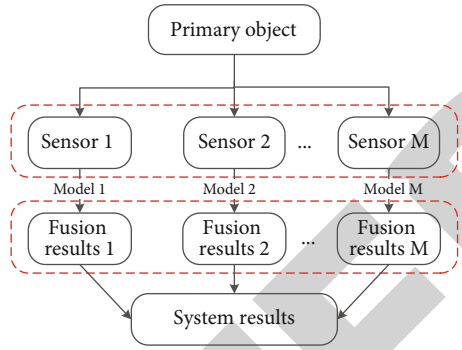

Figure 2: The structure of multisensor information fusion.

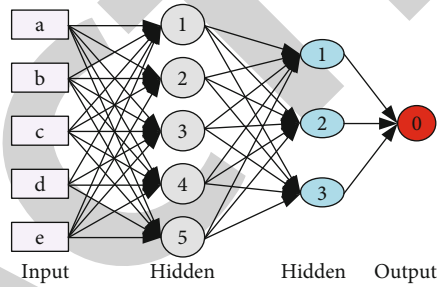

Figure 3: The diagram of multisensor fusion BP neural network.

There are many structure types of neural network. In view of the complexity and uncertainty existing in the security of smart home, this paper selects the relatively mature BP neural network algorithm to fuse the data information collected by the security detection module as (1), where x is the set of real numbers and $f(x)$ belonged to $[0, 1]$.

$$f(x) = \frac{1}{1 + e^{-x}}. \tag{1}$$

In addition to the above activation function, another common activation functions are as follows: the input of neuron of the jth hidden layer is

$$u_j^J = \sum_{j=1}^{J} \left(\omega_{ij} x_{mi} - \theta_j\right). \tag{2}$$

The output is

$$v_j^J = f\left(u_j^J\right). \tag{3}$$

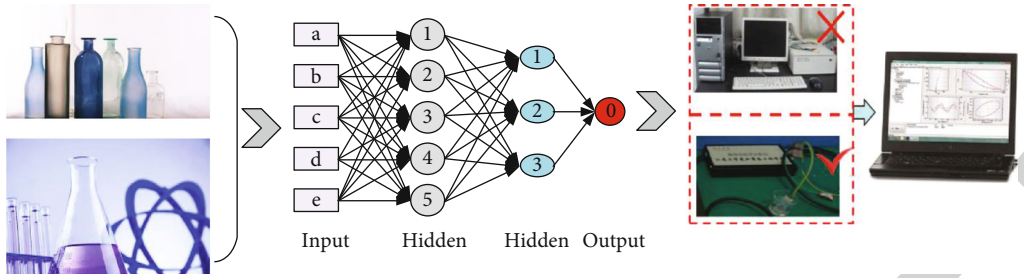

Figure 4: The framework of abnormal concentration detection method of chemical pollutants based on multisensor fusion.

Then, the input of neuron of the kth output layer is

$$u_k^K = \sum_{j=1}^{J} \left(\omega_{jk} v_j^J - \theta_k\right). \tag{4}$$

The output is

$$y_{mk} = v_k^K = f\left(u_k^K\right). \tag{5}$$

Since we assume that the sample is normally distributed, the errors in Formula (6) are normally distributed

$$e_{mk}(n) = t_{mk}(n) - y_{mk}(n). \tag{6}$$

Then, select the next group of input samples, continue the calculation according to the above method, and adjust the parameters. The sum of error energy of the system output layer is

$$E(n) = \frac{1}{2} \sum_{k=1}^{K} e_{mk}^2(n). \tag{7}$$

Then, the propagation of neural network error is opposite to the forward propagation process of neural network system signal, which is propagated from back to front. Therefore, in the error correction process of neural network system, the system will correct the weight and deviation from back to front. In the BP neural network algorithm, the error energy of the expected output is positively correlated with the partial derivative of the weight of the hidden layer and the output layer, i.e.,

$$\frac{\partial E(n)}{\partial \omega_{jk}(n)} = \frac{\partial E(n)}{\partial e_{mk}(n)} \cdot \frac{\partial e_{mk}(n)}{\partial y_{mk}(n)} \cdot \frac{\partial y_{mk}(n)}{\partial u_k^K(n)} \cdot \frac{\partial u_k^K(n)}{\partial \omega_{jk}(n)}. \tag{8}$$

According to the definition of the system and all known relations,

$$\begin{aligned} \frac{\partial E(n)}{\partial e_{mk}(n)} &= e_{mk}(n), \\ \frac{\partial e_{mk}(n)}{\partial y_{mk}(n)} &= -1, \\ \frac{\partial y_{mk}(n)}{\partial u_k^K(n)} &= f'\left(u_k^K(n)\right), \\ \frac{\partial u_k^K(n)}{\partial \omega_{jk}(n)} &= v_j^J(n). \end{aligned} \tag{9}$$

Accordingly, there are

$$\frac{\partial E(n)}{\partial \omega_{jk}(n)} = -e_{jk}(n) \cdot f'\left(u_k^K(n)\right) \cdot v_j^J(n). \tag{10}$$

Based on the above discussions, the framework of abnormal concentration detection method of chemical pollutants based on multisensor fusion proposed in this paper is given in Figure 4. It mainly includes the collection of chemical substances, the establishment of multisensor fusion BP neural network, and the output and analysis of model results.

4. Experimental Results and Analysis

4.1. Experimental Data Introduction. With the rapid development of modern agriculture, chemicals are playing an increasingly important role in actual production. China's chemical varieties, chemical production is large, and the use is increasing year by year. In the use of chemical substances, due to improper spraying or long-term residual in the environment, there is not only food and environment pollution to varying degrees but also harm to human health, so the concentration of chemical pollutant detection and control is particularly important.

Water samples from the surrounding waters of a city were collected, mainly in the urban areas, mainly near the estuary of rivers and sewage outlets. In addition, samples were also collected from several reservoirs in the city to monitor the quality of water sources. A total of 28 sampling sites were set up, and samples were collected in waters 4 m away from the shore with a self-made sampling device. 0.5 L of water samples was collected from the surface water of each sampling site and placed in a brown bottle protected from light. Then, samples were brought back to the

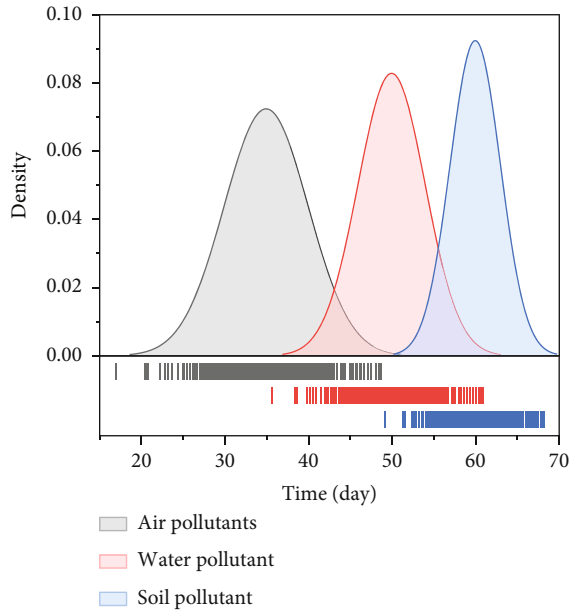

Figure 5: The variation of concentration of different kinds of chemical pollutants.

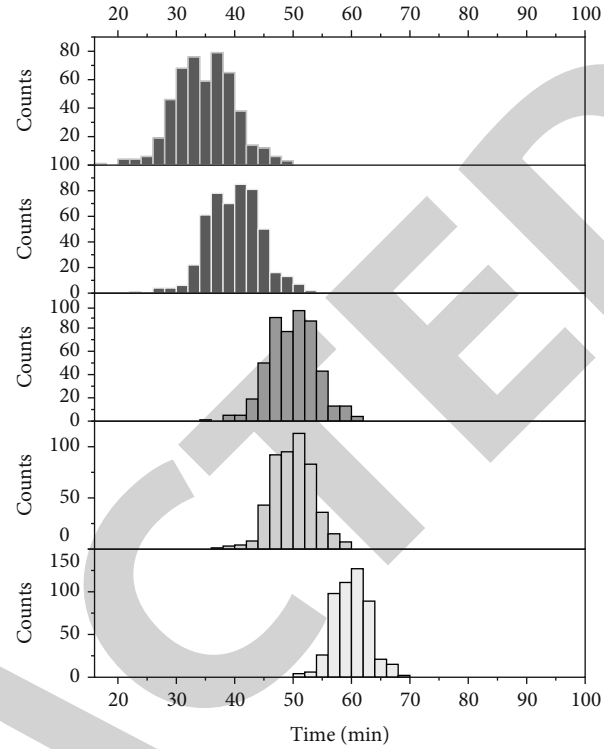

Figure 6: Comparison of peaks of different elution gradients.

laboratory at low temperature and stored at 2°C, and the pretreatment of samples was completed within one week.

4.2. Experimental Result Analysis. Before the study, the variation rules of concentration of several typical chemical pollutants (air pollutants, water pollutants, and soil pollutants) are presented, as shown in Figure 5. As can be seen from the figure, although the types of pollutants are different, their concentration changes show a positive distribution pattern of increasing first and then decreasing. The main reason is that at the beginning of the pollution, the concentration of pollutants should not be very high. With the increase of the degree of pollutants, the concentration of pollutants will gradually increase and reach the maximum. Then, due to rain erosion, air circulation, and the volatilization of pollutants, the concentration of pollutants will gradually decrease and reach the minimum value. Although the concentration of chemical pollutants will be reduced for various reasons, if the concentration of pollutants is still reduced under natural conditions, it will not only take a long time but also the pollution caused during this period is unacceptable. Therefore, it is necessary to test the concentration of pollutants manually.

One of the important functions of liquid chromatography is to improve the response value by adjusting the ratio of different organic and inorganic phases for gradient elution and separating the spectral peaks of various target substances and optimizing the peak shape. The results of liquid chromatography analysis of pollutants outputted by BP neural network are shown in Figure 6. As you can see from the figure, the first subgraph uses a high proportion of organic phases. Although the peak time of the target substance is short, it is concentrated within 30~40 min, and the peak overlap is serious, the peak shape is poor, and some target substances have low response values. In the second subgraph, the separation degree of the target object is reduced by increasing the initial organic phase proportion, and the organic phase proportion increases slowly, which slows down the phenomenon of peak overlap of the subsequent target object. The results showed that the peak of the target substance was concentrated in 40~45 min, indicating that the initial organic phase proportion was large and needed to be optimized again. The similar situations can also be seen from the subsequent subgraphs, and it can be seen that the concentration detection effect of chemical pollutants is more and more obvious by the multisensor fusion BP neural network. It is worth noting that the concentration peak time of the three pollutants is not the same, mainly because of the volatilization degree of the three pollutants.

Dilute 20 mg/L mixed standard solution with 20% acetonitrile-80% 0.1% formic acid aqueous solution to 70 μg/L, 55 μg/L, 40 μg/L, 25 μg/L, 10 μg/L, and 0 μg/L step by step to prepare the target pollutant concentration required by the standard curve. The standard curves of some agricultural drug targets obtained are shown in Figure 7. It can be seen from the table that the linear correlation coefficients of 8 pesticide standards are all greater than 0.998, and the detection limits of this method are 0.05 ng/L~0.91 ng/L, indicating that this method has a good linear range, low detection limit, and high sensitivity.

In order to further verify the effectiveness of the proposed method, the detection results of the proposed method at different pollutant concentration levels (10 μg/L, 1000 μg/L, and 1000000 μg/L) are presented, as shown in Figure 8, where the red curve is the true concentration value, and the blue

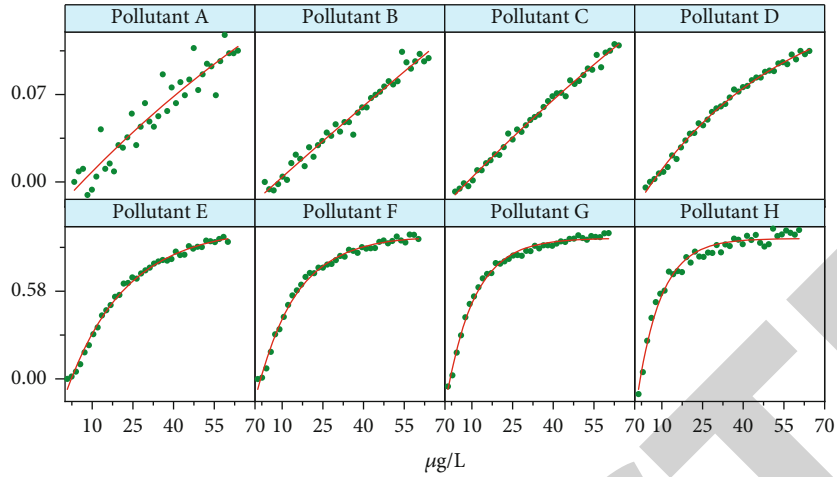

Figure 7: Standard curve for partial detection of contaminants.

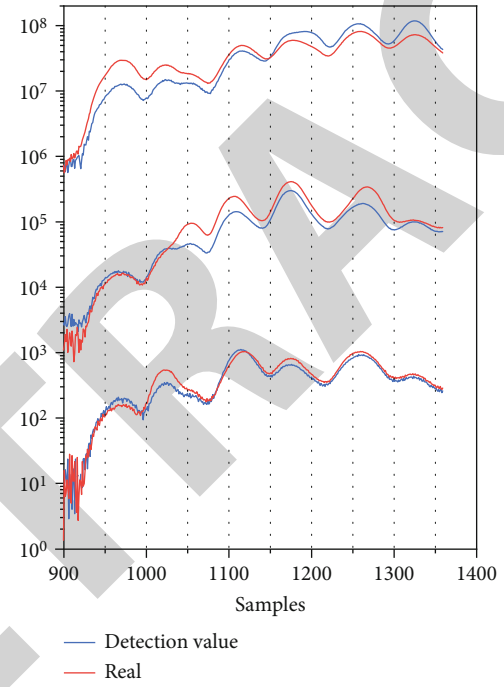

Figure 8: The relationship between the true value and the detected value at different concentration levels.

curve is the detected concentration value. As can be seen from the figure, the method presented in this paper can track the concentration change curve of chemical pollutants well with the increase of sample number at different concentrations, which indicates that the method presented in this paper has a good detection effect of pollutant concentration. It is worth noting that the abscissa here is randomly selected in the range of 900 to 1400 as a verification of the method in this paper.

In addition, the method in this paper is also used to detect the concentration of chemical pollutants in natural waters, and the specific results are shown in Figure 9. As can be seen from the figure, the concentration of metolachlor in this method exceeded 50% from January to August, and the highest proportion was 88%. It indicates that metolachlor is the main pollutant in this water region. By contrast, prometryn has a low percentage of no more than 7% in all months, indicating low levels of the pollutant in the water domain. In addition, it can be seen from the figure that butachlor accounts for the second most. In addition, the concentrations of acetochlor and bromacil were similar, that is, they were not the highest in different months. The above results are compared with the local environmental protection test results, and the two results are consistent, thus demonstrating the effectiveness and reliability of the method presented in this paper. It is worth noting that the change of chemical pollutant concentration often takes a long time, so we chose January to August as a representative period.

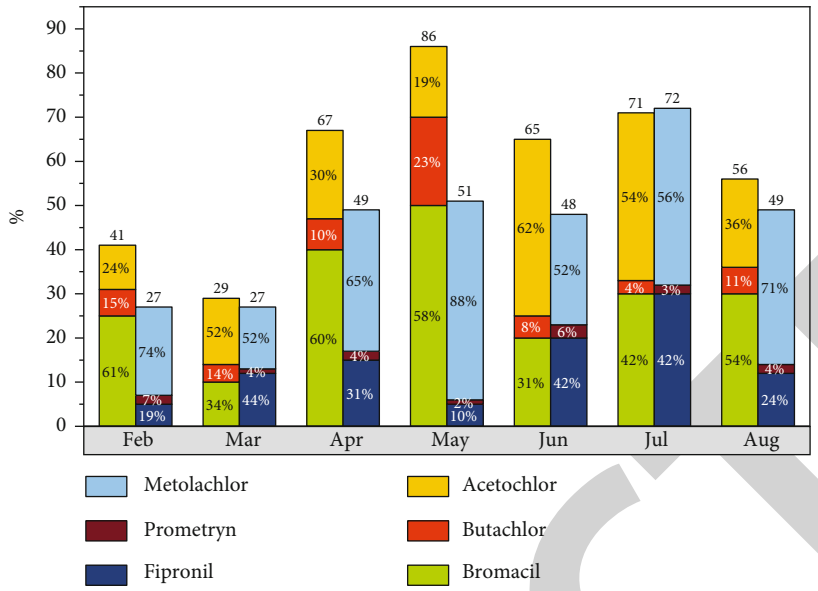

Figure 9: Percentage of total detected pollutants.

5. Conclusions

Chemical pollution is an important problem which needs to be solved urgently in China. It is related to ecological balance and human health. The current work of chemical pollutants in water environment in China is time-consuming, laborious, and complicated.

In view of the shortcomings of existing problems, in this paper, a method for abnormal concentration detection of chemical pollutants based on multisensor fusion is designed. Through simulation and verification, we can see that the system information fusion is feasible. The method not only has good detection accuracy but also can achieve stable model performance. Based on the work done above in this paper, there are still many places to be improved and upgraded. In the future work, we hope to realize the combination of methods and Internet and network the detected signals to achieve remote control and online detection. Although the proposed multisensor fusion method achieves good results, the current method is based on shallow BP neural network, and future research can focus on the multisensor fusion based deep model.

Data Availability

The datasets used during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The author does not have any possible conflicts of interest.

Acknowledgments

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Retraction

Retracted: Analysis of Green Financial Policy Utility: A Policy Incentive Financial Mechanism Based on State Space Model Theory Algorithm

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] Q. Wan, J. Qian, and M. Yu, "Analysis of Green Financial Policy Utility: A Policy Incentive Financial Mechanism Based on State Space Model Theory Algorithm," *Journal of Sensors*, vol. 2022, Article ID 5978122, 13 pages, 2022.

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Research Article

Analysis of Green Financial Policy Utility: A Policy Incentive Financial Mechanism Based on State Space Model Theory Algorithm

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In recent years, in the context of "double carbon" and innovation-driven synthesis, the volume of green finance has been growing year by year, and the intensity of environmental regulation has been stabilizing. As green financial technology innovation cannot be separated from the support of financial market and government policies, how to promote green financial technology innovation with green finance and environmental regulation has become a hot issue. How to control the appropriate strength of environmental regulations to promote green financial technology innovation is a matter of continuous exploration by local governments. The research of this paper is about the utility analysis of green finance policy: a policy incentive financial mechanism based on the state space model theory algorithm. Therefore, this paper introduces the theory of green finance based on the state space model algorithm and neural network model algorithm to study China's green finance policy incentive mechanism, profoundly study the current situation of domestic green finance development, and put forward further strengthen the leading role of the government in green financial innovation. At the same time, suggestions for achieving coordinated regional development were made in terms of giving full play to the role of financial markets in promoting green technology innovation.

1. Introduction

At present, under the comprehensive background of carbon neutrality and carbon peaking, China has stepped into a path of economic development from the early rough development to the transformation to a new high-quality economy. In terms of ecological protection, China has experienced a transition from pollution to green development, with economic development and ecological protection complementing each other. The "14th Five-Year Plan" as China's old economic system to a high-quality new economic system of green transformation of an important period, green technology innovation is the key to the transformation of the old and new dynamic energy. The report of the 19th Party Congress and the latest 14th Five-Year Plan of China have clearly instructed to escort the transformation of China's high-quality development and green development from two aspects: laws and regulations and government policies. Since the ecological environment is the most important resource endowment in China, the integration of environmental protection into the intervening financial market system is the basis and prerequisite for the transformation of green development and is also the main trend of future technological innovation development. Nowadays, how to establish a green technology innovation system stimulated by the market is attracting the attention of the society. However, China's green technology investment is still seriously insufficient, the relatively single financing channel for environmental protection enterprises is a major obstacle to the development of green technology, and the green financial market has not fully played a positive role in promoting green technology innovation. The lack of

green technology innovation has led environmental companies to rely on government policy support, a situation that limits the sustainability of green technology innovation. How to synergize green finance, environmental regulation, and green technology innovation to promote the green transformation of the economy has become a key issue.

Green finance is the foundation and condition of green innovation. Along with the policy idea of carbon peaking and carbon neutral, low-carbon development has become the funding orientation of financial market. Green finance has played a key role in supporting the green development of various industries in various regions of China. In the first half of 2021, China's green finance policy made a leap forward: first, China became the first country in the world to label "carbon neutral" green bonds and successfully issue carbon neutral bonds; secondly, government departments involved in green bonds unified the criteria for green projects for the first time; the People's Bank of China (PBOC) issued the "Green Financial Assessment Program for Banking and Financial Institutions" again. The People's Bank of China has once again released the "Green Financial Assessment Program for Banking and Financial Institutions," which has set a complete evaluation standard for the entire green financial system. As China's green financial system becomes more complete, the scale of China's green financial market continues to grow at an accelerated pace. By the end of 2020, our green foreign currency loan balance will be about 12 trillion yuan, jumping to the first place in the world; the stock of green bonds will be about 800 billion yuan, ranking second in the world. The volume of green finance is growing rapidly. By the end of June 2021, China's domestic and foreign currency green loan balances had reached 14 trillion yuan, up 26.5% from the same period last year. In the first eight months of 2021, it exceeded the total emissions of green credits in 2020. Green debt issuance exceeded 350 billion yuan, an increase of 152% compared to the same period last year, with a total of 180.1 billion yuan of carbon neutral bonds issued [1].

Green technology innovation is inseparable from the support of environmental regulation. The development path of environmental regulation in China started from zero and has experienced the initial exploration of "prevention-oriented," then the medium-term development of "prevention and control," and finally, to the present "priority of ecological protection." The environmental regulation policy system has also undergone a series of changes. The environmental regulation policy system has also undergone several strategic reforms. The policy thinking has changed from the "pollution prevention view" to the "ecological development view," and now, it is on the way to the "green development view." As the tools for environmental protection mature, they range from direct government involvement to market-driven environmental regulation, and finally, to voluntary environmental regulation involving all Chinese people and businesses. The overall system of environmental regulation in this new era has been gradually improved from top to bottom and from the inside out. In order to meet the latest national goal of "double carbon" to complete the transformation of China's green development, we should further build a synergistic system of China's environmental, financial, and innovation policies to jointly complete the construction of China's ecological civilization.

2. Research Background

Compared with the revolution of domestic green finance research, foreign processes have begun earlier. Salazar [2] believes that green finance includes multiple disciplines, focusing on combining finance with the environment, and can better protect the ecological environment. In addition, he also said that in the development of green finance different, the former focuses on the impact of its future environmental changes, while the latter focuses on its impact on all aspects of society and economy [3]. Cowan [4] believes that green finance is produced by the integration of financial industry and environmental protection. The development of green finance has promoted in-depth cross-integration between environmental economics and finance [5]. Labatt and White [6] pointed out that green finance is a new type of innovation tool that can effectively disperse environmental risks and improve environmental quality [7]. On the basis of further exploring the conduction mechanism between sustainable development and finance, it analyzes the positive impact of green finance on the raised funds of financial institutions from cross-disciplinary levels and pointed out that green finance is to coordinate finance and environmental protection. What is produced by common development, green finance refers to the optimal solution to financial institutions that can clear resource and environmental problems based on integration of various financial instruments [8]. Andarson [9] believes that the most important purpose of developing green finance is to invest in environmental protection. At present, banks will also inspect whether the loan owner will consider environmental factors [10]. Sachs et al. [11] believe that green finance is committed to sustainable development goals and run through innovative financial instruments and policies to increase investment intensity of environmental protection projects and increase environmental benefits [12].

Although domestic scholars started later in the research of green finance, they also formed some achievements. Gao [13] pointed out that green finance emphasizes that financial institutions must consider environmental issues when making major strategic decisions and advocate the combination of economic development and ecological environmental protection to promote sustainable economic growth [14]. An Wei [15] believes that green finance combines the development of the traditional financial industry with environmental protection and promotes the sustainable economic development through energy conservation and emission reduction [16]. Tang [17] summarizes the theoretical basis of developing green finance and the current development status of green finance in my country. It is concluded that the development of green finance requires scientific and reasonable use of financial instruments such as green bonds, green credit, and green funds to promote the construction of ecological civilization [18]. Yu [19] believes that the so-called green finance is to use scientific and technological

innovation to use some products or services of the traditional financial industry to develop more environmentally friendly causes to promote the sustainable development of the financial industry [20]. Qin and Wang [21] summarize the existing definitions. In general, the fundamental essence of green finance is a series of green financial product portfolios under the guidance of the government [22]. Wang [23] pointed out that green finance can drive green environmental protection-related enterprises and the overall industrial development, thereby driving more economic growth benefits [24]. He [25] sorted out the origin of green finance, connotation, and theoretical development context and summarized the purpose of green finance to lead social capital to the green industry.

3. Materials and Methods

3.1. Basic Theory

3.1.1. Green Finance. As early as 1990, environmental protection was introduced into the financial field by foreign scholars. The initial purpose is to clarify the connection between environmental protection issues and financial development, so the initial green finance is also called environmental finance or sustainable development finance. According to the connotation of early environmental finance, Chinese scholars took the lead in proposing the concept of "green finance," which refers to the activities of investing funds into environmental protection and energy-saving activities. This article will use Anwei [26], Ma [27], and others to define green finance: with the guidance of coordinating the economy, resources to protect the environment, and through environmental protection policies to allow financial services to enter environmental protection, energy conservation, emission reduction, etc. [28]. Provide corresponding financial policy support for environmental protection to achieve green financial operations. Further, analyze from the perspective of regulation. Ye [29] and others believe that market-type regulatory tools must have price attributes, such as taxation, charging, investment, and credit to affect the company's decision-making through price signals. Its connotation incorporates green finance into the market-oriented tools [30].

Although domestic and foreign scholars are not consistent with the concept of green finance, they are included in the financial system standards. Green finance is essentially the purpose of protecting the environment and energy conservation through financial and environmental policies to standardize the financing behavior of enterprises. On the one hand, it encourages the environment-friendly behavior of enterprises, on the other hand, limits the development of high pollution and high energy consumption enterprises and adjust the industrial structure to optimize the allocation of resource allocation with the purpose of green development. This article will outline the component of green finance from the following five parts:

(1) *Green Credit*. Green credit is a unique concept of my country. Foreign scholars usually call green credit as environmental protection financing. Scholtens [31] argues that green credit is the act of commercial banks that grant loans based on the environmental friendly performance disclosed by companies and their social responsibility [32]. Anderson [33], on the other hand, argues that the lending behavior that uses the environmental friendly performance of a company as a basis for review is green credit [34].

Chen [35] proposed that green credit incorporates the responsibility of environmental protection into bank lending policies based on the traditional credit model and is an economic instrument to achieve environmental protection through the financial market [36]. Chen [37] argue that green credit does not only work in the field of environmental protection but also in pollution-intensive industries such as traditional manufacturing [38]. Hu et al. [39] argue that green credit is a new type of credit policy adopted by banks from the perspective of bank revenue, which changes the traditional business model and aims to enhance profitability and public reputation, and that green credit can channel funds into state-supported energy-saving and environmental protection industries and curb the emissions of highly polluting enterprises. Sun et al. [40] argue that green credit has a double meaning: one, it is the act of helping to finance environmentally friendly industries according to bank lending guidelines. Second, it is the act of loans granted by banks to achieve sustainable development. The green credit referred to in this paper is proposed by He and Zhang [41], and Chen [42]: the act of banks to reallocate their lending resources to meet the environmental policies issued by the state. Highly polluting enterprises are given interest rates with penalties to discourage their emission behavior, and industries in the environmental protection field are given lower interest rates and audit thresholds to encourage their development [43].

(2) *Green Insurance*. The connotation of green insurance is divided into broad and narrow: green insurance in the narrow sense refers only to environmental pollution liability insurance. The insurance takes effect after the pollution act has occurred, the insurance company pays for the pollution act on behalf of the polluter, and compulsory purchase is an important feature of the insurance

(3) *Green Securities*. This security should be accurately described as an environmental audit of the company during the listing process, which usually includes environmental audits of the listed company, environmental information omissions, or environmental performance assessment. Usually, the audit can improve the public reputation to obtain broadened financing channels

(4) *Green Investment*. Green investment is also called environmental protection investment, and Zhang [44] believes that environmental protection investment is the government-led investment behavior, which is an important part of China's national

economy. Peng [45] believes that the government, enterprises, and individuals can become the main body of investment in environmental protection investment. The role of environmental protection investment is to increase the capital stock of environmental protection to achieve the purpose of continuous environmental improvement. Environmental protection investment is an important part of green finance, which can usually form fixed assets greater than one year

(5) *Carbon Finance*. The definition of carbon finance is still controversial in academic circles, but at present, it can be basically determined that carbon finance is divided into two definitions: broad and narrow. Chen [46] believes that the broad definition of carbon finance should be restricted to the process of carbon emission, and the government uses financial instruments to reduce carbon emissions as a financial market instrument, while the narrow definition is the process of trading carbon emission rights by enterprises at the micro level (World Bank, 2011)

Green finance in essence is to regulate the financing behavior of enterprises through financial and environmental policies to achieve the purpose of environmental protection and energy conservation. On the one hand, it encourages the environment-friendly behavior of enterprises, and on the other hand, it restricts the development of high pollution and high energy consumption enterprises to adjust the industrial structure to optimize resource allocation with the purpose of green development. The specific 5 types of classification are shown in Figure 1.

3.1.2. Green Financial Technology Innovation. Green financial technology innovation is derived from Schumpeterian innovation theory. Schumpeter's innovation theory emphasizes the crowding-out effect of environmental regulation on technological innovation and believes that environmental regulation will eventually hinder technological innovation. In addition to the crowding-out effect, the uncertainty of technological innovation is another major factor that hinders technological innovation in Schumpeter's innovation theory, and environmental regulation will also increase the risk brought by the uncertainty of technological innovation. Therefore, this paper splits the impact of environmental regulation on technological innovation in Schumpeter's innovation theory into the crowding-out effect and the risk-averse effect. This paper categorizes firms' motivation to obtain compensation as the pushback effect and the technology barrier effect.

In summary, the theoretical framework of the overall impact of environmental regulation on green financial technology innovation is shown below, and the analysis of the transmission path of the impact of environmental regulation on green financial technology innovation should be analyzed from the above four paths to determine its hindering and incentive effects, as shown in Figure 2.

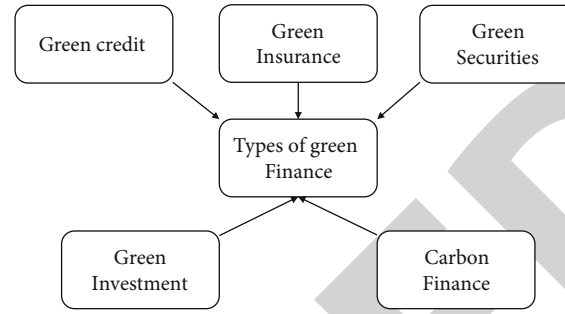

Figure 1: Types of green finance.

3.2. Research Methodology

3.2.1. State-Space Model Theory Research Method. The state space model is a dynamic time-domain model with implicit time as the independent variable. State space models are increasingly used in economic time series analysis. The typical correlation model, proposed by Akuchi and further developed by Mehra, is the most widely used state space model. The models are specifically classified into two major categories and four subcategories, as shown in Figure 3.

The state space models are based on the steganalysis of time series. To analyze a (nonsmooth) time series, the (trend) components should be divided into arbitrary, low, and low values. A time series containing random mapping components is also an integrated time series, since the random walk is a sum or integration of weak stable components. When the linear sequence (continuous power connection) of some sequences is reduced, the rotation sequence is called a parallel process. The idea of creating linear sequences of unstable time series can be traced back to regression analysis. The coordinate proposed by Granger has been scientifically proved. Studies by Aoki, Cochran, and others have shown that in many nonfixed and unpredictable time series, arbitrary velocities are much smaller than previously thought, or have disappeared altogether.

3.2.2. Research Method of Neural Network Model. RBF neural network (radial basis function neural network, RBFNN) is one of the most typical three layer forward neural network structure, in addition to the traditional neural network of information processing way, the underlying layer using radial basis function to the nonlinear mapping the input data, and then it goes to the next layer through a linear calculation. The structure of RBF neural network is shown in Figure 4.

RBF neural network is mainly from the two parts of the input data for processing, the two parts, respectively, for supervised learning and unsupervised learning, in unsupervised learning section, by using clustering algorithms such as K-means for data clustering, to obtain the center of the hidden layer radial basis function, and then make use of information center of the width of the radial basis function

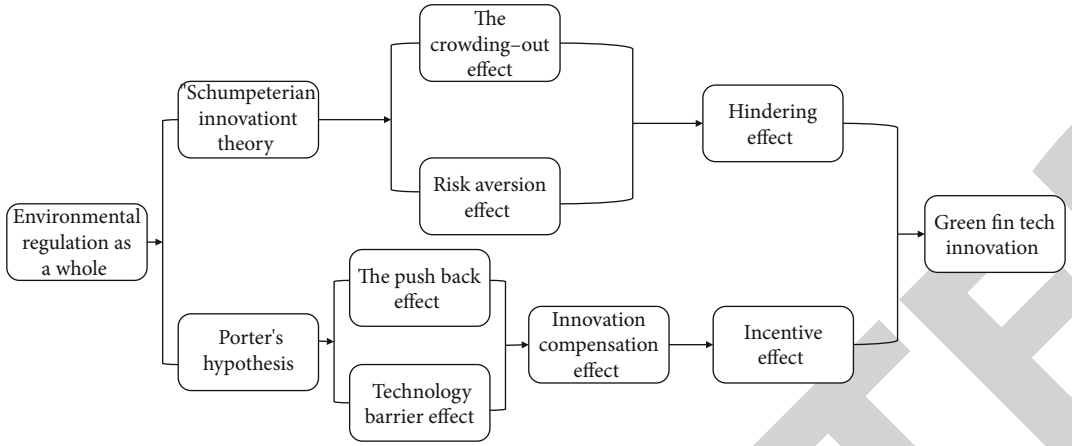

Figure 2: Mechanism of green financial technology innovation.

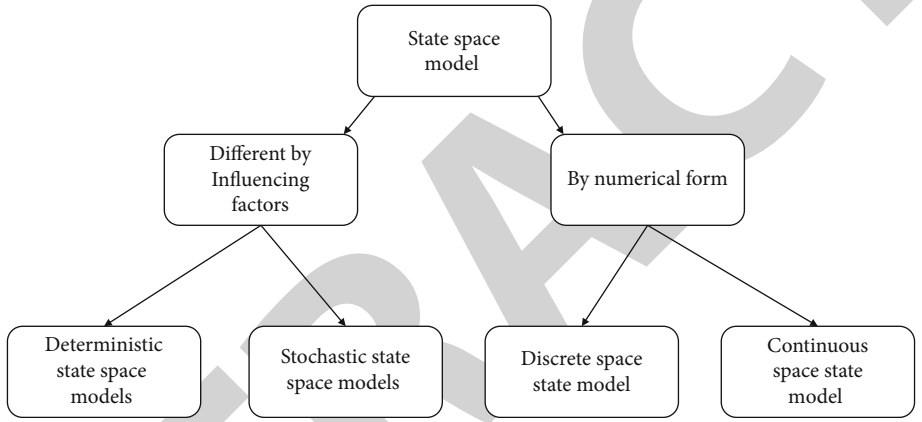

Figure 3: Classification of state space models.

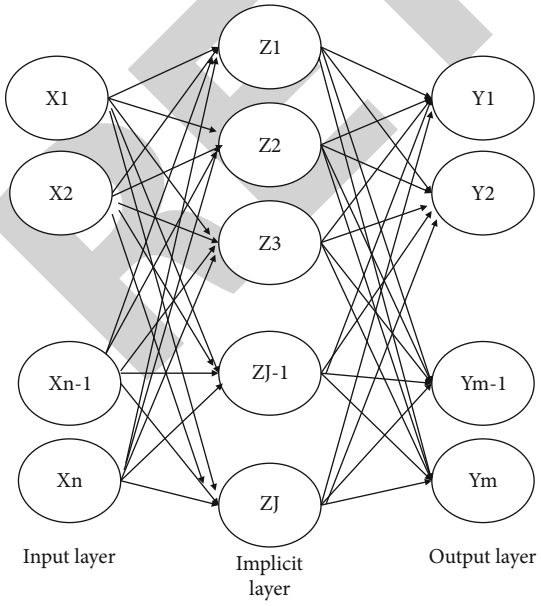

Figure 4: Structure diagram of radial basis neural network.

vector is calculated. The width vector can be calculated as calculated. The width vector can be calculated as follows:

$$\sigma_j = \frac{c_{xy}}{\sqrt{2h}}, \tag{1}$$

where c_{Xy} is the maximum distance before the center point, and h is the number of nodes.

Then, the input data are correlated and dispersed through the hidden layer and output layer, respectively, and the output of the x_i input sample at the j first node of the hidden layer can be calculated by the following formula:

$$\phi(x_i, j) = \exp\left(-\frac{1}{2\sigma_j^2} x_i - c_i\right), \tag{2}$$

where c_j and σ_j are the center point and m width vector of the first node in the hidden layer, respectively.

The output of x_i the input sample at j the first node of the output layer can be calculated by the following formula:

$$y_m = \varphi(\phi(x_i, j) * w_m), \tag{3}$$

where w_m is the node weight φ and is the activation function.

In supervised learning part, mainly on the process of modifying the parameter of each level, mainly through the process error function to calculate the gradient value of each parameter, and then use the traditional gradient descent method such as stochastic gradient descent method (SGD) is used to adjust the parameters, and in terms of output layer is used for linear weight, for example, the update formula is as follows:

$$w_t = w_{t-1} - u * \frac{\sigma E}{\sigma w_{t-1}}, \tag{4}$$

where E is the error function, and u is the learning rate.

In addition to the above methods, the center point and width vectors of hidden layers can be generated randomly and then updated according to the gradient correction formula of supervised learning process.

4. Results and Discussion

4.1. Status Quo of Green Finance. Because green finance is extensive, data is not easy to obtain. Based on the collation of existing literature, this paper finds that various measurement methods of green finance all cover green credit and green investment, and the coefficient accounts for a high proportion. Therefore, green credit and green investment can more easily reflect the status quo of green finance.

4.1.1. Green Credit Status. Under the high-pressure influence of a series of national environmental policies and the continuous attention of all walks of life to ecological issues, major commercial banks have launched green credit projects in succession to cater to national policies. Green credit balance and its proportion in China's banking industry are from 2010 to 2017. It can be seen that since the easing of the international financial crisis in 2010, the balance of green credit has shown a trend of steady growth every year. In recent years, compared with 2010, there is a significant improvement, among which, the green credit balance issued in China in 2020 has a growth rate of 700% compared with the beginning, see Figure 5.

4.1.2. The State of Green Investment. In terms of green investment, this paper uses the total investment in environmental pollution control from 2003 to 2017 and the proportion of GDP to describe the current situation of green investment. According to the chart, China's green investment showed a steady growth before 2014 and then ushered in a slight decline.

From the total investment in environmental pollution control to the total proportion of the national economy, the value fluctuated between 1% and 1.6% over the years and showed a downward trend in recent years after reaching the peak value. This phenomenon shows that the growth rate of green investment in China is much less than that of national economy, see Figure 6.

4.2. Current Situation of Green Financial Technology Innovation

4.2.1. Investment Status of Green Financial Technology Innovation. The R&D investment of green technology innovation mainly includes research funds and researchers, both of which showed a trend of steady growth from 2000 to 2018. In terms of the data of scientific research expenditure, based on the scientific research expenditure in 2000, the increase of scientific research expenditure in 2018 was 2,196%, and the increase of scientific research personnel was 476%. The research expenditure and the research personnel both increased exponentially, see Figure 7.

4.2.2. The Output Status of Green Technology Innovation. The output of green technology innovation is divided into two aspects: patent authorization and patent application, as shown in the Figure, the number of green patent authorization and green application increased slowly year by year before 2010. Due to the implementation of the Amendment of the Patent Law on October 1, 2009, the number of green patent grants and applications rose step by step. In 2015, the number of green patents granted and applied again showed a step increase, but the increase of patent granted was much less than the number of patent applications, see Figure 8.

To sum up, it can be seen from the data in recent years that green finance has a good momentum of development. Green credit data and green investment data both show an increasing trend, and their fluctuations are mostly caused by market shocks. Although green investment shows an overall growth trend, its growth rate is far less than China's economic growth rate. Fee-based environmental regulations are regulated by national policies, and sewage charges float within a certain range every year. Influenced by the policy of replacing sewage charges with taxes, the amount of sewage charges collected has decreased in recent years. The data related to green technology innovation and green finance both show an increasing trend. Among them, the scientific research funds and scientific research personnel showed a steady increase every year, while the number of patent applications and the number of grants showed a step increase. This asymmetry of input and output may be due to the fact that the growth of innovation output is more dependent on the macrocontrol of policy and the protection of intellectual property rights by law.

4.3. Promote the Development of Green Finance Incentive Mechanism

4.3.1. Further Strengthen the Leading Role of the Government in Green Financial Innovation. The impulse response analysis shows that the effect of environmental regulation on green technology innovation is stronger than that of green finance. Therefore, it is particularly important to play the role of government policy in encouraging green technology innovation. Based on the empirical analysis and mechanism analysis, this paper puts forward several suggestions as follows: first, the impulse response results of the whole country and the eastern and central regions have a short-term

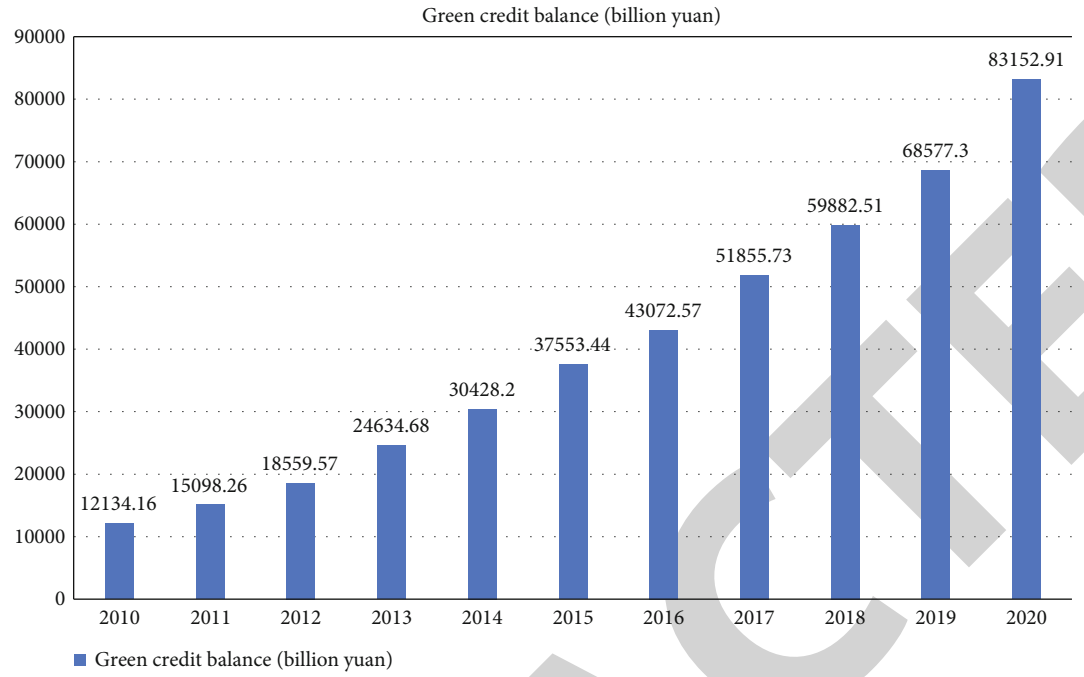

Figure 5: China's green credit balance from 2010 to 2020.

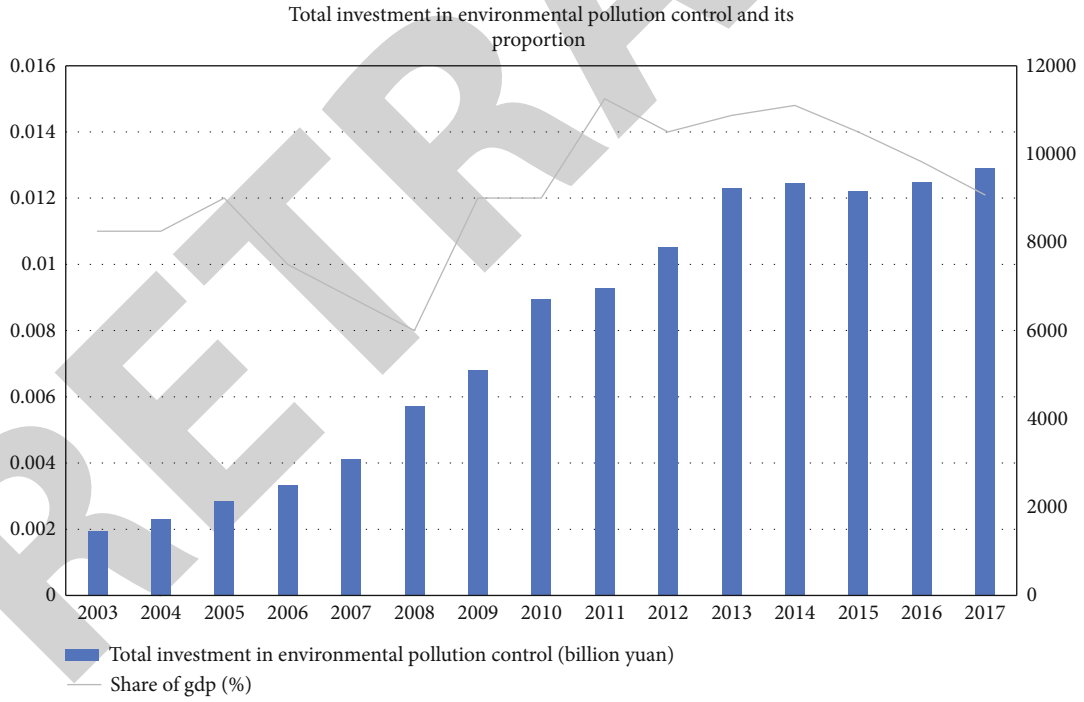

Figure 6: Total investment in environmental pollution control and its proportion in GDP from 2003 to 2017.

positive impact on green technology innovation while a long-term negative impact, which may be due to the deviation in the process of policy implementation. The government should further implement the supervision during the implementation of policies and strengthen the control after the implementation of policies to avoid the "distortion phenomenon" of policies. At the same time, government management departments need to popularize the relevant knowledge of environmental protection policies and green financial system to all enterprises and individuals, so that public participation becomes an important part of policy supervision. Second, on the basis of regional analysis, the obvious regional impact of environmental management on financial innovation in China is analyzed. In view of the

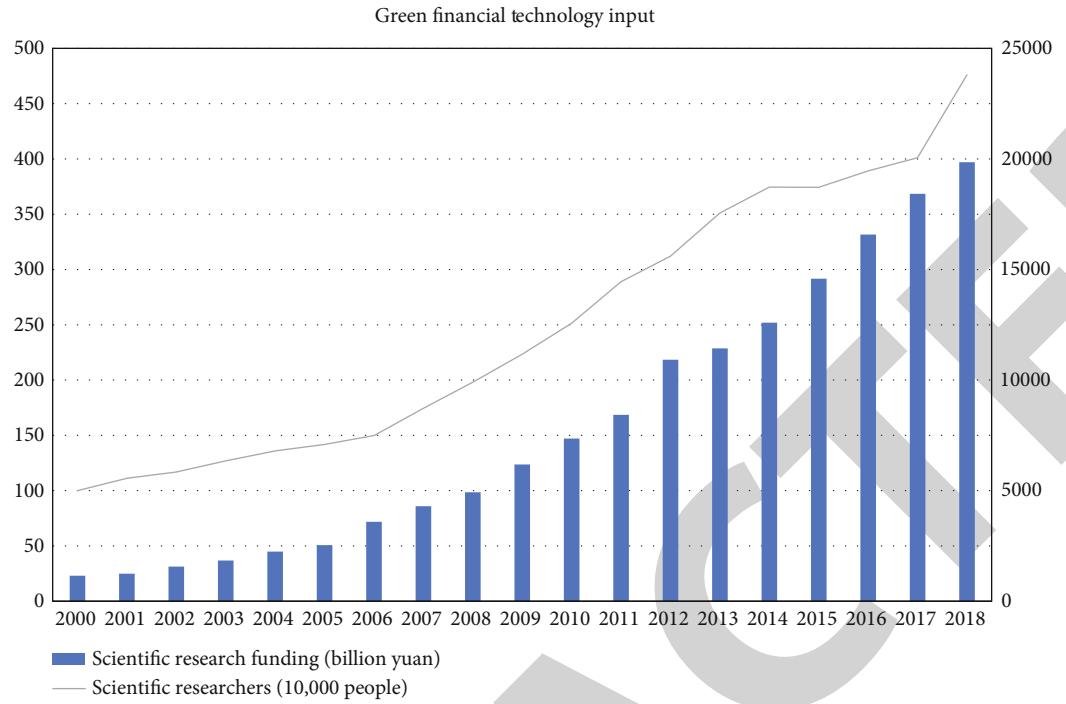

Figure 7: 2000–2018 research funds and researchers.

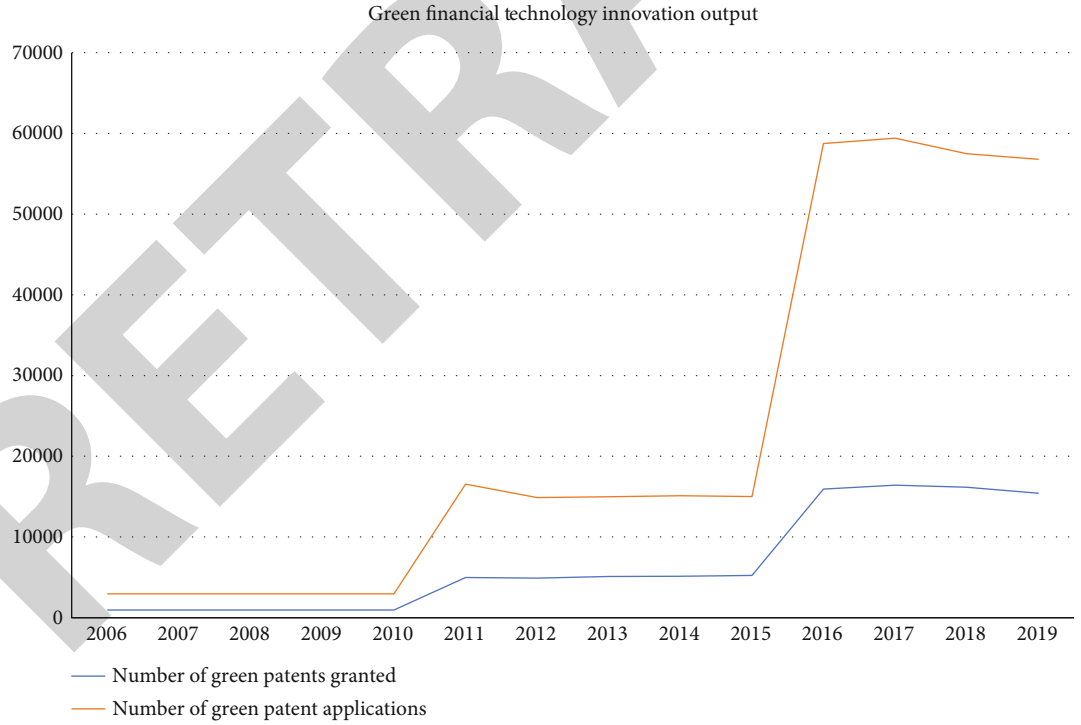

Figure 8: Number of green finance patents granted and green patent applications from 2006 to 2019.

difficulty of implementing regional cost-based environmental regulation policies, each regional government should formulate corresponding supporting policies according to local conditions. In eastern and central regions, environmental regulation rack costs have a greater impact on green technology innovation, should continue to increase on its effect and promote technological innovation, and local authorities in heavily polluted areas should meet access barriers for highly polluting enterprises. In less developed parts of the West, cost-based environmental regulations are holding back

green technology. Local governments in the region should accelerate their own economic development by stimulating investment, helping high-polluting cities share the share of polluting enterprises, and strengthening the impact of environmental regulations on green technology innovation. Second, fee-based environmental regulation and green finance can inhibit and encourage green technology innovation. Therefore, it is very important to grasp the intensity of cost-based environmental regulations and green financial policies. Environmental regulations should not only play a role in promoting energy conservation and emission reduction of enterprises but also allow enterprises to have enough funds for research and development of green technology, so as to improve the production and operation environment of enterprises in the long term.

4.3.2. Play the Role of Financial Market in Promoting Green Technology Innovation. Through mechanism analysis and empirical analysis, this paper finds that when green finance is used as a regulatory tool, it has more hindrance than incentive effect on green technology innovation. Therefore, two policy suggestions are given as follows: first, through comparative analysis of variance decomposition of cost-based environmental regulation, it is found that green finance has weak impact on technological innovation and cost-based environmental regulation. The reason for this phenomenon may be that some green financial products are "non-mandatory" and "fungible" compared with government policies. Therefore, commercial banks should increase marketing efforts to play its role in solving the problem of "preferential treatment" for environmental protection enterprises and "punishment" for polluting enterprises. Second, according to the impulse response results of different regions, the impact of green finance on green technology innovation in western China is weak and negative, which may be due to the lack of environmental protection enterprises in western China. Therefore, city firms in different regions should adopt green financial rules and regulations adapted to the regional environment. For example, the entry threshold of financing should be relaxed in the western regions where pollution is relatively weak. The eastern and central regions with strong pollution should adopt different green credit interest rate benchmark, green insurance coverage, carbon quota, and so on for cities with high pollution enterprises and other cities according to local conditions.

4.3.3. Give Play to the Principal Role of Enterprises in Green Financial Innovation. Through mechanism analysis, it is found that whether enterprises are willing to invest in green technology innovation plays a decisive role in the overall transmission path of environmental regulation on green technology innovation. Based on this, the following suggestions are summarized: first, from the analysis of the current situation, it is found that the asymmetry of R&D input and output of enterprises may be due to the changes in the protection of intellectual property rights by policies and regulations. Therefore, both the government and the public continue to deepen the awareness of intellectual property protection, so as to improve the efficiency of technological output and reduce the risk aversion consciousness of enterprises caused by the uncertainty of technological innovation. Second, give more preferential policies to enterprises that reach the green "threshold." When enterprises reach the technical barrier, they can get rich innovation compensation, so as to stimulate enterprises' investment in green technology research and development.

The green financial system should also continue to improve and develop. First of all, we should establish and improve the performance assessment system of financial institutions, add ESG-related indicators to the assessment indicators, and promote financial institutions to optimize the direction of resource allocation through financial innovation. Second, strengthen supervision to prevent and defuse financial risks. When the old regulatory regime fails to effectively identify new financial risks, it increases systemic risk in the market, leading to financial panic. Therefore, regulatory authorities should effectively prevent potential risks such as idle funds, high leverage, and related transactions in the green financial system through functional supervision and macro and microprudential supervision tools, so as to ensure the steady development of the green financial system. At the same time, when providing financial products and services, financial institutions should establish a self-discipline mechanism for green finance, carry out relevant stress tests, and strengthen risk management. For accounting firms and credit rating agencies, the independence and objectivity of audit and rating should be adhered to, and suspicious risk points should be revealed in a timely manner, so as to achieve the purpose of supervision. Finally, improve green finance laws and regulations to ensure that there are laws to follow. On the one hand, relevant laws and regulations have been formulated to ensure that financial institutions are legal and compliant in their business exhibitions. At the same time, strict restrictions have been imposed on the flow of funds of financial institutions to ensure the standardized development of green finance business. On the other hand, through the publicity and interpretation of green finance laws and regulations, improve the environmental awareness of various enterprises and institutions.

4.3.4. Improve the Strength of Green Finance and Strengthen the Support for Green Economy. For high-risk green credit projects, commercial banks can focus on supporting the development of green industry by optimizing loan approval, mortgage, and other processes. At the same time, commercial banks can also reduce the problems of insufficient liquidity and increased risk of bad debts caused by green credit business through asset securitization and other ways to ensure the soundness of commercial banks' operations. Second, the development of green securities will be the focus of green financial product innovation. Therefore, on the one hand, China should accelerate the improvement of the current capital market system, give full play to the function of the capital market, and put social capital into the development of green economy more accurately. On the other hand, green enterprises should continue to strengthen scientific and technological innovation, form core competitiveness, and constantly improve their own business capabilities, so

as to reach the listing threshold of each exchange and enrich the source of funds. Third, PPP model is an effective way for social capital and government finance to cooperate in investment projects. On the one hand, after the introduction of social capital, PPP model can solve the problem of government financial strain; on the other hand, PPP model can also bring a perfect investment management mechanism, so that project funds can be invested in a market-oriented way. Therefore, PPP model can be introduced to support the development of local green industry. In addition, China's current green insurance varieties are relatively single, unable to meet the risk management needs of enterprises. Therefore, insurance institutions should innovate insurance varieties for customers with different risk types and give full play to their role in reducing environmental risks. Finally, strengthen the combination of green finance and fintech, make full use of digital technologies such as big data and block chain, strengthen the risk assessment of small and microenvironmental protection enterprises, and alleviate the problem of insufficient funds for small and microenvironmental protection enterprises.

4.3.5. Increase the Proportion of Green Industry and Promote the Optimization and Upgrading of Industrial Structure. After decades of rapid development, China's economy has entered the second half of reform. Both the external environment and internal growth drivers are in urgent need of transformation. From the perspective of production, China's previous industrial structure was dominated by traditional industries such as energy and infrastructure, and the inherent economic development mode only focused on quantity rather than quality, resulting in serious overcapacity in traditional industries and serious environmental pollution and resource loss. From the perspective of consumption, the Internet industry has brought about the reconstruction of consumption mode and the consumption upgrade brought by the rise of the middle class, and ecological and environmental problems are increasingly valued. And the green economy transformation program can not only solve the environmental risk of production end but also meet people's consumption demand. Therefore, it is imperative to optimize and upgrade the industrial structure in the direction of greening.

As mentioned above, environment, as a public good, has externalities. In the face of market failure, the government needs to strengthen policy guidance and support the development of green industry. Therefore, on the one hand, the government can support the development of green environmental protection industry through tax and fee reduction policies, such as the mature tax subsidy policy for new energy vehicles, the government can promote and upgrade this policy, which is widely used in solid waste treatment, building energy conservation, garbage power generation and other fields, and give tax incentives. First, policy guidance should be adopted to help enterprises extend industrial chains, build ecosystems, upgrade manufacturing business models, and transform traditional industries into green ones. Second, on the one hand, real enterprises should keep up with the trend of national economic development, improve their core competitiveness through scientific and technological innovation, eliminate backward production capacity in time, and improve industrial added value. Second, all kinds of enterprises should consciously abide by relevant laws and regulations, take the initiative to disclose environmental information in a timely manner, and take the initiative to bear the environmental costs caused by their own operations. Third, to establish residents' awareness of environmental protection, and force relevant enterprises to carry out supply-side structural reform from the consumption side to reduce environmental damage. Fourth, the majority of universities and research institutions can jointly train relevant high-tech talents with enterprises, accumulate high-quality human capital through the integration of industry and education, and provide impetus for the transformation and development of the corresponding structure.

4.3.6. Strengthen Regional Economic and Financial Cooperation to Achieve Coordinated Regional Development. According to the above analysis, it can be seen that there are large differences in the development of green finance and green economy in the eastern economic belt of China. Among them, the overall level of green finance and green economy development in Yangtze River Delta and Pearl River Delta is higher; the overall level of green finance and green economy development in Beijing, Tianjin, and Hebei is lower. And specific to the provinces, the northern region of Liaoning Province green finance, green economy development level as a whole is low, and Beijing-Tianjin-Hebei region has not yet formed a good synergy effect, so the regions should strengthen economic and financial cooperation to achieve the coordinated development of regional green economy, green finance. First of all, we should strengthen the exchange and learning of experience. On the one hand, the backward regions can learn advanced governance experience from the developed regions and actively introduce relevant policies and measures to promote the transformation of industrial structure in the region; on the other hand, the developed regions can strengthen the talent assistance to the backward regions and help the backward regions to establish and improve the green finance and green economy system. Second, a sound regional coordination and linkage mechanism should be established. Provinces should not only establish consistent principles of ecological protection and green economy development standards, so that provinces (cities) within the region can complete industrialization transformation according to unified regulations, but also establish and improve the command and coordination mechanism of financial, environmental protection, and financial institutions in each province to solve the problems of regulatory arbitrage and regulatory loopholes, so as to realize the overall improvement of regional green economy development level. Finally, when the development of green economy in developed regions tends to be saturated, social capital and leading green environmental protection enterprises in the region can be guided to invest in green industries in backward regions, which not only improves the utilization rate of resources but also helps backward regions to achieve rapid development.

5. Conclusion

China's general policy basically requires that the transformation of China's high-quality development and green development should be escorted from two aspects: laws and regulations and government policies. Between the ecological environment is the most important resource endowment in China, to include environmental protection into the intervention financial market system is the basis and prerequisite for the transformation of green development. Therefore, this paper introduces the theory of green finance based on the study of China's green financial policy incentive mechanism through the state space model and other algorithms, deeply studied the current situation of domestic green financial development, and put forward relevant suggestions on the current situation of China in the financial policy incentive mechanism.

(1) Further strengthen the leading role of the government in green financial innovation. The national impulse response comparison analysis shows that the intensity of cost-based environmental regulation on green technology innovation is greater than that of green finance on green technology innovation. Therefore, it is particularly important to play the role of government policies in stimulating green technology innovation. Based on the empirical and mechanistic analyses, this paper makes the following recommendations: first, the impulse response results for the whole country and the east-central region have a short-lived positive effect on green technology innovation and a long-term negative effect, which may be due to the bias in the policy implementation process. The government should further implement the supervision during the policy implementation and strengthen the control after the policy implementation to avoid the "distortion" of the policy

(2) To play the role of financial market to promote green technology innovation. City banks in different regions should adopt green financial regulations that are compatible with the environmental conditions of their regions. For example, the weaker polluted western region should relax the access threshold of financing for enterprises; the stronger polluted eastern and central regions should also adopt different green credit interest rate benchmarks, green insurance coverage, carbon rights quota, etc. for cities with high polluting enterprises and other cities according to local conditions

(3) Play the main role of enterprises in green financial innovation. The willingness of enterprises to invest in technological innovation plays a decisive role in the transmission path of environmental regulations affecting green technological innovation as a whole. Accordingly, the following policy recommendations are made: the asymmetry of enterprises' R&D inputs and outputs found from the analysis of the current situation may be due to the changes in policies and regulations for the protection of intellectual property rights. Therefore, both the government and the public continue to deepen their awareness of intellectual property protection as a way to improve the efficiency of technological output and reduce enterprises' awareness of risk avoidance due to the uncertainty of technological innovation

(4) Improve the strength of green finance and strengthen support for the green economy. For high-risk green credit projects, commercial banks can focus on supporting the development of green industries by optimizing the process of loan approval and mortgage pledge. At the same time, commercial banks can also reduce the problems of insufficient liquidity and increased risk of bad debts brought by green credit business through asset securitization and other means to guarantee the soundness of commercial banks' operation. Second, the development of green securities will be the focus of green financial product innovation. China should accelerate the improvement of the current capital market system and give full play to the functions of the capital market to invest social capital more precisely in the development of green economy

(5) Increase the proportion of green industries. Now that we have entered the second half of reform, both the external environment and internal growth drivers are in urgent need of transformation. From the production side, China's previous industrial structure is mostly based on traditional industries such as energy and infrastructure, and the inherent way of economic development only focuses on quantity rather than quality, which leads to serious overcapacity in traditional industries and brings serious problems of environmental pollution and resource depletion. From the consumption side, the Internet industry has brought about a reconfiguration of consumption patterns, superimposed on the upgrading of consumption brought about by the rise of the middle class, and ecological and environmental issues are receiving increasing attention

(6) Strengthen regional economic and financial cooperation to achieve coordinated regional development. All regions should strengthen economic and financial cooperation to realize the coordinated development of regional green economy and green finance. First, we should strengthen the exchange and learning of experience. On the one hand, the backward regions can learn advanced governance experience from the developed regions and actively introduce relevant policies and measures to promote the transformation of industrial structure in the region; on the other hand, the developed regions can strengthen the talent assistance to the backward regions and help the backward regions to establish and improve the green finance and green economy system

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Retraction

Retracted: Construction of a Multimedia-Assisted Teaching System for English Courses in a Multimodal Sensing Environment

Journal of Sensors

Received 23 January 2024; Accepted 23 January 2024; Published 24 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] X. Weng, "Construction of a Multimedia-Assisted Teaching System for English Courses in a Multimodal Sensing Environment," *Journal of Sensors*, vol. 2022, Article ID 3775658, 10 pages, 2022.

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Research Article

Construction of a Multimedia-Assisted Teaching System for English Courses in a Multimodal Sensing Environment

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With the advent of the information era, education reform has also sounded the call for in-depth reform and development. In order to cope with the development needs of modern society's economy and political culture, the importance of English, as the mainstream language of international communication in the world today, is also self-evident. In rapid development of science and technology, network multimedia-assisted teaching has also been developed rapidly, while the teaching methods and teaching outcomes of foreign languages have been the focus of people's attention. The diversified development of students and changes in science and technology has been driving the improvement and construction of teaching systems based on the English curriculum. In today's multimodal sensing environment, a personalized recommendation algorithm of cluster analysis algorithm + collaborative filtering is introduced to complete the construction of the teaching system, and the superiority of the system is demonstrated by questionnaire survey and performance analysis comparison with teachers and students as the main research targets. The aim is to fully integrate the new media context and multimodal sensing environment in this environment, and to use in this environment, we aim to fully integrate the new media context and multimodal sensing environment and use multimedia technology to assist the construction of the teaching system.

1. Introduction

The research on the combination of English courses and multimedia-assisted teaching was proposed by scholars as early as 1994, and Wang et al. clearly stated in his paper that he should make full use of multimedia technology to create a three-dimensional construction of college English teaching materials: graphic environment for students to learn English [1]. In 2001, due to the continuous development of multimedia technology, a scholar proposed a study on the use of multimedia-assisted English audio-visual teaching, in which the scholar discussed the psychological and linguistic foundations of the use of multimedia-assisted English audio-visual teaching from different theoretical perspectives, respectively, from the psychological level, linguistic level, and cognitive theory level. The research proposed by the scholar can well expand the students' receptive and input-output ability for English audio-visual culture [2]. With the comprehensive development of network technology, more and more universities are aware of the importance of multimedia technology-assisted English teaching, and scholars never stop thinking about the level of multimedia-assisted English teaching, and by 2009, a research scholar put forward some thoughts on multimedia-assisted college English teaching: while stressing the importance of College English itself, the scholar also pointed out that college English is indispensable in college teaching. The effect of English teaching will affect the students' English application ability, and the author proposed to introduce multimedia technology into college English teaching activities in this context, but the author did not give the exact teaching plan in his paper [3]. The feasibility of the multimedia technology-assisted English teaching system was not demonstrated until 2020, when a paper titled "Multimedia-based Assisted English Situational Teaching in Junior High School" was presented in which the authors tried to apply an interactive multimedia system to junior high school English teaching activities [4].

However, the conclusions of the abovementioned studies based on multimedia-assisted English teaching are mostly theoretical and basically theoretical, which do not bring the application capability of multimedia-assisted English courses into

full play. With the deeper excavation of English teaching mode, many research scholars have shifted from theoretical English course teaching to the study of the building multimedia-assisted teaching system.

And in today's situation where students' diversified development and communication are increasingly prominent [5], the construction of teaching systems for English courses in a multimodal environment is particularly important, while making full use of multimedia technology-assisted English teaching is more conducive to students' ability to bring their diversified development into full play, as well as to enhance students' diversified cognition and cultivate their diversity awareness. To sum up, this paper is aimed at building a teaching system for English courses from the perspective of using multimedia technology to assist English teaching in a multimodal sensing environment.

2. Research Background

2.1. The Connotation of Multimodal Sensing Environment. According to the first section, since the research is based on the multimodal sensing environment, what is the multimodal sensing environment? Modern language scholars consider language as a social sign as well, and not only that, scholars also extend the social sign of language to other signs [6]. In today's social development, thanks to the convergence of new media contexts, individual symbols complement each other, influence, and interact with each other. And the role of modality is indispensable in the formation of a language.

Some scholars believe that modality refers to the way and medium of communication, including related technology, language, and images; others believe that modality is a way of interaction, a way for humans to communicate with the external environment through visual and auditory means.

In this paper, multimodality refers to the way people interact in different environments, including the medium and channels of communication through factors such as language, color, images, and related technologies. Multimodal sensing environment is defined in this paper as the diversity and variety of students and students, students and teachers, and teachers and teachers in the English language environment under the English course teaching, which includes multiple scenarios of language application, different constructions of the same language expressions, and students' communication in real life.

2.2. Significance of the Construction of Multimedia-Assisted English Course Teaching System. The English teaching curriculum cannot be separated from the teaching of audiovisual speech, which is a basic ability necessary for students to learn English and learn to speak English, and is of great significance in improving the overall quality of students learning a foreign language. However, in today's traditional English curriculum, teachers' teaching methods are very single and difficult to integrate with the diversified development needs of modern students. In addition, although there are many teaching resources in China, there is no corresponding sharing channel between colleges and universities, which leads to the deviation of the teaching level and the utilization of teaching resources in each college, thus leading to the uneven mastery of English by students in different colleges and universities at the same level. Some colleges and universities even teach English for the purpose of teaching English, forgetting that the essence of teaching English is to develop students' ability to use English for communication in different aspects. The English teaching in China is not only detached from the reality but also has the problem that many students only write test papers and answer questions due to the system of test-based education, which only results in "dumb English."

Interest is the best teacher for students to learn in school; so, in order to reduce the situation of "dumb English," English teachers should find ways to improve students' ability to learn English. However, the traditional English course teaching is a stage for English teachers alone, and students are only the audience under the stage; the boring English classroom makes many students have a headache when they see English, not to mention the interest in learning English. With the progress of technology and the development of multimedia-assisted English course teaching, building a multimedia-assisted teaching system for English course in a multimodal sensing environment is the need of contemporary education reform and one of the most effective ways to bring students to the big stage of English course [7]. Therefore, in today's multimodal sensing environment and diversified development of students, the construction of a more complete and personalized recommended multimedia teaching system for English courses is one of the powerful e-learning aids in English teaching. The construction of a more complete multimedia teaching system that can accomplish personalized recommendation is one of the powerful aids for using e-learning in English teaching, which is of great significance. The specific significance of using multimedia technology to assist English teaching system in multimodal sensing environment can be described as follows.

2.2.1. The Combination of Graphics and Text Is Conducive to Simplifying Difficulties. Unlike mathematics courses, where formulas and calculations are common, English is first a language and then a subject, and the essence of language is a bridge for people to communicate. English teaching is divided into four levels: listening, reading, writing, and speaking, which improve students' English in many ways. According to psychological tests, students can gain more knowledge in the course by using visual teaching compared to auditory teaching [8]. Compared with the traditional teaching mode of "blackboard + books," multimedia-assisted English teaching is conducive to simplifying the complicated knowledge points and making them easy, especially for the more abstract and profound grammar such as the definite clause in English grammar. In particular, for abstract and profound grammatical points such as definite clauses in English grammar, the teaching method of illustration and text can make students understand the relevant knowledge more thoroughly, especially the use of pictures, videos, or animations is more intuitive and visual .

2.2.2. Enhancing Students' Interest in Learning and Stimulating Their Potential to Learn English [9]. Interest is the best teacher, and it enables students to overcome difficulties and stimulates their potential to learn English. Students' interest in learning

can correct their learning motivation, turn passivity into initiative, and enhance subjective motivation, and a stimulating learning style plays a key role in students' learning efficiency and teachers' teaching quality. Therefore, English teachers should fully exploit the interest factor and artistic charm in English teaching materials, combine the civics elements with the teaching syllabus, and apply multimedia technology to teach with interest. In the traditional teaching mode, the teacher is the authority of teaching, and the students are sitting under the podium listening to the lecture and can only passively think and accept the knowledge irrigated by the teacher, which is difficult to stimulate students' interest in learning English. It can transform boring English knowledge into interesting, vivid, perceptive, visual, and audible kinesthetic content. When students are placed in a cooperative and open teaching atmosphere, their interest will be actively mobilized. Building a multimedia-assisted English course system is a perfect way to integrate students' individual recommendations and achieve a collaborative and open teaching atmosphere.

2.2.3. Multimedia-Assisted Instruction Makes the Introduction of English Courses More Distinctive. The introduction of English courses has been underappreciated by most schools because of the solidity of teachers' thinking, but the quality of a course's instruction is often the beginning, or even the key, to its success. A concise and compelling introduction to a course is crucial for students who are not yet in the learning mode. For example, a short animated presentation can make students feel the content and meaning of a lesson, a small video can show a story vividly, and a distinction can be made between qualifying and nonqualifying clauses. Either pictures or animations or small videos can make students integrate into the classroom faster, and at the same time, the animation and visualization of knowledge can stimulate students' interest in learning.

2.2.4. Improve Classroom Efficiency and Pay Attention to the Cultivation of Practical Application Skills [10]. The teaching efficiency of any course is an extremely important indicator, which is not only related to the amount of knowledge students learn in a certain class but also related to the overall mastery level of English and the teaching quality of teachers. For example, when teachers teach phonetic symbols, traditional English courses are taught by teachers one by one, and students are forced to memorize them one by one, but with multimedia technology, teachers can demonstrate the pronunciation patterns directly on the slides through animated slow motion, so that students can understand the pronunciation and patterns at a glance. This greatly enhances the teaching efficiency of the classroom. At the same time, the teaching of English should not be a test-based teaching, but a teaching that is integrated with the real life. If we do not pay attention to the expression of English in the real world, the English that students learn is just dumb English. However, the use of multimedia can greatly avoid this situation, and teachers can use multimedia technology in the course to create scenarios, bring students into the role of the situation, and let them actively express their ideas in English in the immersive teaching scenario, to achieve the teaching purpose of strengthening students' English oral expression ability [11].

3. Materials and Methods

3.1. Principles of Constructing the New System. Based on the premise of multimodal sensing environment, this paper proposes the construction of a multimedia-assisted teaching system for English courses with completeness that can guide teachers how to stimulate students' learning interests, as well as provide personalized recommendations for students and strong resource support for teachers, under the new teaching model of fully integrated multimedia-assisted English courses [12]. However, before building the new teaching system, the design and construction principles are first proposed to address some problems in the teaching activities of English courses mentioned in Section 3. In a word, the construction of the new system proposed in this paper will be based on the construction principles stated next .

3.1.1. Focusing on the Cultivation of Students' Interests, with Students as the Theme and Teachers as the Guide. The traditional English classroom, where the English teacher "directs" himself/herself from the podium, is no longer suitable for the needs of contemporary education. Modern English teaching requires teachers to change from a knowledge transmitter to a knowledge sharer, i.e., from a dominant position of transmitting knowledge to a service-oriented position. The new multimodal teaching environment of the new generation challenges the traditional teaching model and requires it to be transformed. The new English teaching is no longer just about the knowledge imparted but about creating conditions for students' development based on the student-themed, teacher-led principle and making full use of multimedia technology to assist English teaching interaction and comprehensively enhance students' interest in learning English .

3.1.2. Focusing on Theory and Practice and Fully Considering Students' Overall Development. Whether it is basic education or higher education, the teaching of a subject is inevitably theoretically inseparable from practice. For English teaching, if only theoretical knowledge is emphasized in the classroom and teachers teach with the test-taking mentality of making students pass exams, it is actually unfavorable for students' development, especially for the cultivation of their creative consciousness. Therefore, in the process of constructing the new system, teachers will be fully considered and required to make full use of multimedia technology to create situations and other activities in the process of English teaching activities, fully combine theoretical knowledge with practice, and at the same time consciously encourage and cultivate students' innovative consciousness in the teaching practice, so as to reduce the phenomenon of "dumb English." The students are encouraged and cultivated to be creative in their teaching practice, so as to reduce the phenomenon of "dumb English."

3.1.3. Diversified Teaching and Personalized Recommendation. Each link and each step designed by teachers when making teaching cases should serve the teaching purpose and syllabus. The links and links and steps and steps should be complementary and interconnected. And one of the most important actors that should not be missing in the design of teaching sessions is diversity and personalized recommendations.

However, many teachers nowadays tend to lack the importance of articulation when creating syllabi or teaching PPTs, and the rigid connection between teaching sessions makes students' efficiency in class extremely low, and even logical cognitive errors may occur, which in turn affects students' efficiency and performance in the whole English learning process.Therefore, the new system constructed in this paper will fully consider this teaching principle and use the relevant personalized recommendation algorithm to build the system, which can provide a certain theoretical basis for teachers' teaching behavior, and adopt the concept of real-time updating to grasp the real-time dynamics of classroom teaching, which can allow teachers to adjust the teaching plan and PPT design in a timely manner, thus improving the teaching efficiency of the English classroom and providing teachers with the opportunity to improve the teaching efficiency of the English classroom on time. This allows teachers to adjust the teaching plan and PPT design, thus improving the teaching efficiency of English classroom and providing aids for teachers to complete the teaching content on time and in quality.

To sum up, the new system proposed in this paper is constructed: firstly, under the premise that the contemporary educational environment is a multimodal sensing environment and students should be diversified, with the multimedia-assisted English teaching mode as the leading mode, the reasonable use of multimedia technology to assist teaching activities and in the teaching practice to make full use of the advantages of multimedia technology such as illustration and text to continuously explore the interest factors of students in order to enhance students' interest in learning. In addition, in order to improve the construction of the new system, this paper also proposes the introduction of personalized recommendation algorithms to fully consider the interests of students and the needs of teachers, in an effort to provide students and teachers with a comprehensive and new teaching system based on multimedia-assisted English courses.

3.2. General Framework of the New System Design. According to the above discussion and analysis, interest is the best teacher for learning, but nowadays, many colleges and universities do not pay attention to the cultivation and exploitation of interest [13]. Therefore, this paper introduces the idea of algorithm in building a multimedia-assisted English course teaching system based on the integrated multimodal sensing environment to address this problem.

At the advent of the 6G era, both economy and science and technology have been greatly developed, and the research field of algorithm has only been increasing; as we can see from the introduction of the first section, many researches today are theoretical studies on English courses and rarely introduce the idea of algorithm, much less actually consider the important element of "interest measure" [14]. In this paper, in order to make the new system more relevant and more personalized and humanized, a personality recommendation algorithm is introduced, in which the overall block diagram of the multimedia-assisted teaching system for English courses in the multimedia sensing environment is proposed as shown in Figure 1.

As can be seen from Figure 1, the layered modules of the multimedia-assisted English teaching system designed in this paper can be composed of three parts: the student module, the teacher module, and the administrator module. For the student module, the student enters the teaching system as a student and then selects the corresponding module of English learning to enter the learning (if you want to practice listening, you can click on the listening part in the user interface and then select the form of listening learning to learn).

The student module not only includes relevant learning videos and corresponding exercises but also combines the principle of diversity, adding the arrangement of the corresponding course list, relevant learning resources, and learning materials, and fully combines the characteristics of flipped classroom + mobile learning, providing an integrated learning system for students to prestudy, review, participate in cloud classroom discussions, and complete classroom assessments and coursework, etc. The teacher module is a platform for teacher users to use the teacher's name and password.

The teacher module is a system space for teacher users to enter the English course system as teachers, and the teacher module has certain administrator's privileges. The teacher's privileges include not only posting course resources and assignments but also leading discussions with students on difficult issues and posting announcements in the system. The teacher's role in the system is mainly to be a "leader" and "guide" in a cooperative and win-win way and should abandon some old "authority" ideas, and the system should be used as a "springboard" to integrate the principle of "student-themed, teacher-directed" system in the teaching process.

In the administrator module, the user enters the space of the English course teaching system as an administrator, and the administrator module should have the highest authority, because the administrator is the builder who maintains the safe and stable operation of the whole teaching system. The administrator not only monitors the operation of the whole system but also provides the whole service and technical support for all teachers and students.

3.3. Overview of Personalized Recommendation Algorithm. From Section 3.2, it can be seen that this paper introduces the idea of algorithm to explore the interest factors of students, and in order to better explore the interest factors of students, this paper will use the personality recommendation algorithm to implement. Next, the relevant personality recommendation algorithm is described.

The personality recommendation algorithm is a large class of algorithms, in which the framework of personality recommendation algorithm classification can be shown in Figure 2.

As can be seen from Figure 2, personality recommendation algorithms can be basically divided into four categories, which are deep learning algorithms, clustering algorithms, collaborative filtering, and association rule algorithms. Among them, deep learning algorithms are also a big category, and one of the more famous ones is the recommendation system algorithm of YouTube. The algorithm mainly consists of two neural networks, one for sorting data and one for content generation. In the YouTube algorithm, the authors make full use of the idea of data mining to collect users' browsing history

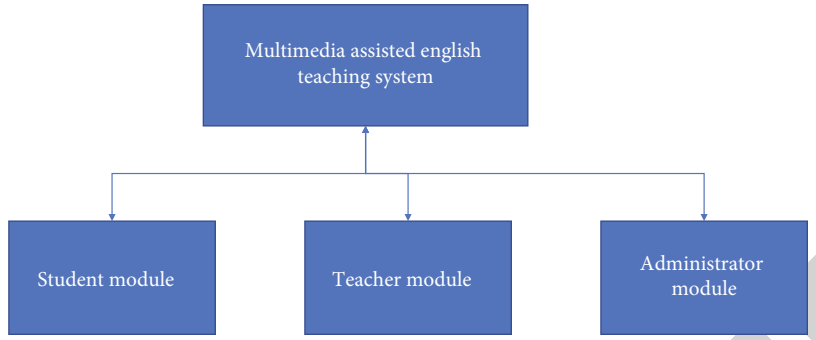

Figure 1: Each hierarchical module of the multimedia-assisted English teaching system.

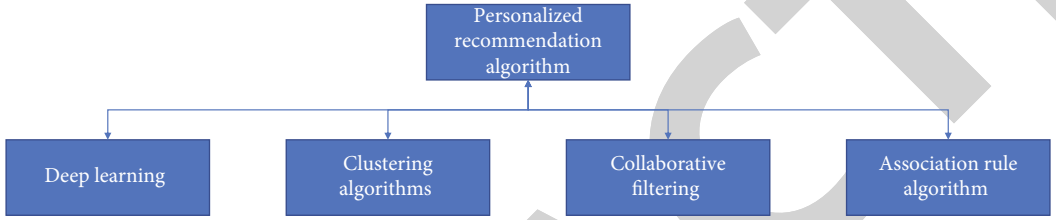

Figure 2: The basic classification framework of the personality recommendation algorithm.

in order to generate candidate neural networks, which in turn can select a set of most relevant videos from a huge library and subsequently predict the user's rating. From the above algorithms, we can see that the algorithms based on deep learning are all related to the correlation algorithms of neural networks, which are used to analyze the relevant data to obtain the correlation between transactions and transactions, finally judge the strength of the obtained correlation, and then select the most suitable content to recommend and display to users. For example, the ReLU activation function can be used in CNN networks to achieve nonlinearization of the neural network. The formula of this activation function is as follows.

$$\mathrm{ReLU} = \max(0, x). \tag{1}$$

The second one used is the clustering algorithm. Why can the clustering algorithm be considered as a personality recommendation algorithm? One of the primary reasons is the principle of the clustering algorithm. The essence of the clustering algorithm is to calculate the distance between the points of clusters by the relevant formula of Euclidean distance, then the transactions with strong attribute correlation will be grouped in the same cluster, and those with weak attribute correlation or hardly any correlation will be grouped in another cluster, so that the huge data or transactions can be classified to achieve the effect of personalized recommendation to users. From the above, it is clear that the essence of applying clustering algorithms to personalized recommendations lies in identifying groups of users and recommending the same performance to different users within this group. One of the commonly used in clustering analysis algorithms is the calculation of Euclidean distance, and the formula is shown below.

$$\mathrm{Dis}\left(x_i, y_j\right) = \sqrt{\left(x_{i1} - Y_{j1}\right)^2 + \left(x_{i2} - Y_{j2}\right)^2 + \cdots + \left(x_{\mathrm{in}} - Y_{jn}\right)^2}. \tag{2}$$

The third one used is collaborative filtering. The English name of collaborative filtering is collaborative filtering, which can be abbreviated as CF. CF has two classic basic methods: the first is user-based collaborative filtering: this filtering algorithm simply makes full use of the historical data of all users, discovers their preference degree for a certain thing, then can mine the neighboring user groups with similar attributes by certain criteria of preference degree, and finally personalizes the recommendation by the target users with the preference degree of a certain thing by the neighboring user groups. The second type is item-based collaborative filtering. As the name suggests, this collaborative filtering is very similar to the principle of the first algorithm, but the item-based collaborative filtering only needs to calculate the similarity between users and use it as a way to calculate the similarity between items. After the similarity is calculated, the nearest neighbors of unrated items are predicted, and the predicted results are finally fed back to the users. For the collaborative filtering algorithm, the evaluation methods generally used are Euclidean distance, cosine similarity evaluation method, etc., where the evaluation method of cosine similarity is shown in the following equation.

$$T(X, Y) = \frac{X \bullet Y}{\|X\|^2 + \|Y\|^2}. \tag{3}$$

The fourth one is the association rule algorithm. The association rule algorithm mainly uses the attributes between the data to specify the relevant rules and then achieves the purpose

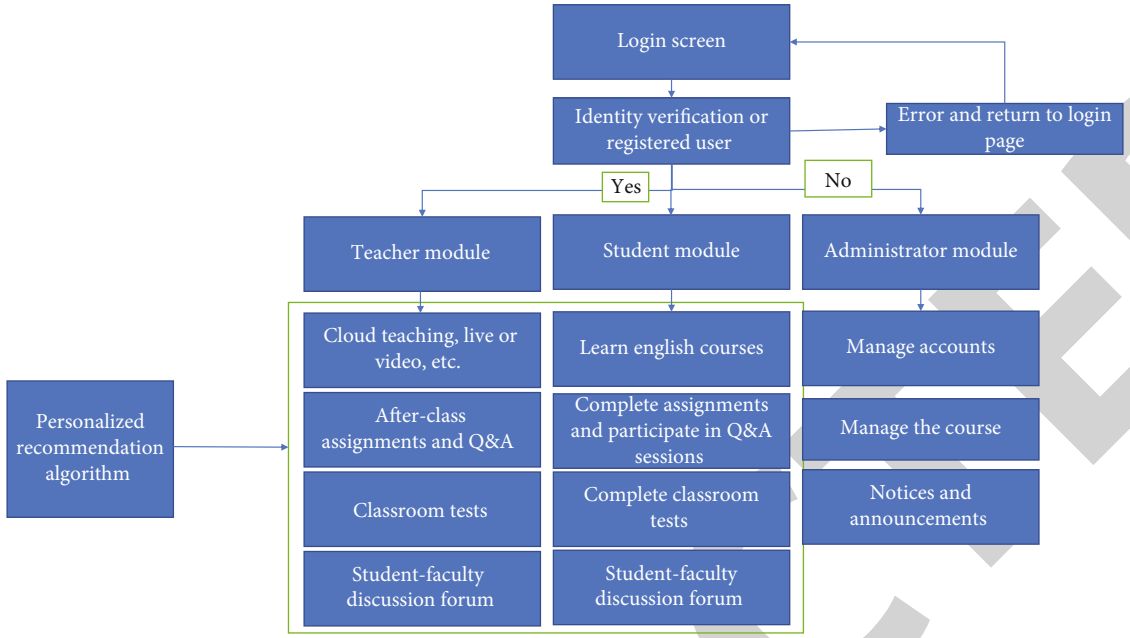

Figure 3: The general framework of the construction of the multimedia-assisted teaching system for English courses based on multimodal environment.

Table 1: Satisfaction indicators of students' evaluation of the effectiveness of the English teaching system.

Evaluation indicators	Content
A1	The teaching effect of the course is very good and rigorous
A2	Focus on teaching learning methods and cultivating students' abilities
A3	Able to master the main contents and methods of the course
A4	Laid the foundation for my future study and work with good practical application scenarios
A5	Helps me to dare to speak English in real life and develop my practical skills

Table 2: Teachers' satisfaction indicators in evaluating the effectiveness of teaching based on the English teaching system.

Evaluation indicators	Content of indicators
B1	Students' prestudy results before class
B2	Students' mastery of knowledge in the classroom
B3	Students' completion of homework after class
B4	How well students answer questions before and after class
B5	Students' discussion in the discussion forum after class

of personalized recommendation. Since the association rule algorithm is not used in this study, it is not discussed in detail.

4. Results and Discussion

Through the above analysis, it can be seen that the traditional teaching method of English classroom is not conducive to the diversified development of students, and in order to improve the teaching quality of teachers and the learning efficiency of students, this paper will implement a multimedia-assisted English teaching system for English courses by means of experimental discussions based on the construction principles of the system in Section 3. Among them, the general implementation framework of the system can be shown in the following Figure 3.

As can be seen from Figure 3, the system distinguishes three modules based on different users, corresponding to the general framework of the new system in Figure 1. Among them, this paper will introduce the personality recommendation algorithm in the teaching form and content of the system.

Comparing Figures 3 and 1, it can be seen that this paper divides the English course into four parts under the teacher

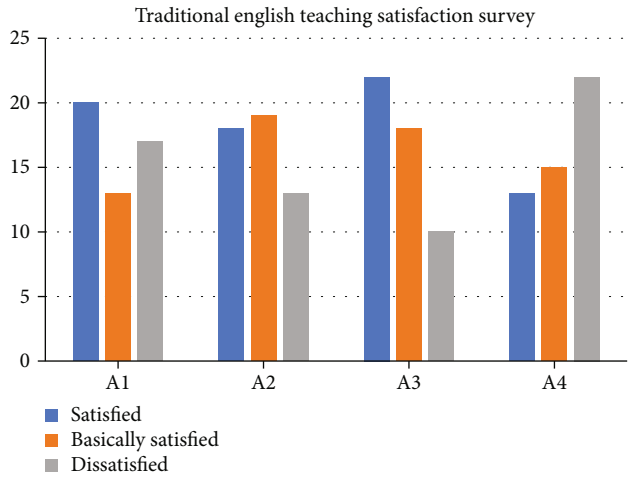

Figure 4: Satisfaction survey of students based on traditional English course teaching platform.

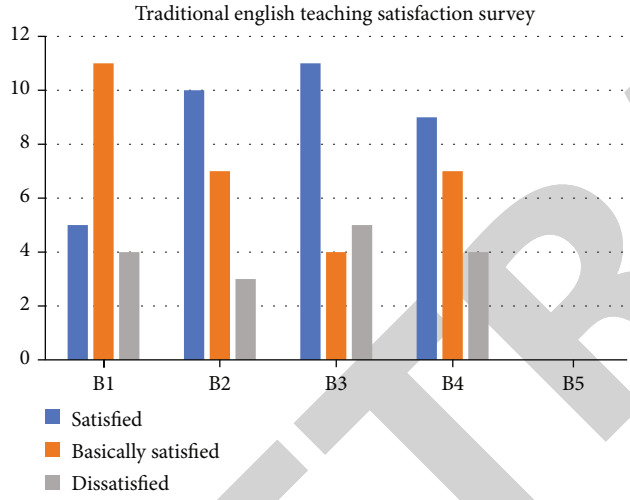

Figure 5: Satisfaction survey of teachers based on traditional English course teaching platform.

module by the characteristics of the course, namely, cloud teaching, using forms such as live streaming or video, after-class homework and Q&A, class tests, and teacher-student discussion forum. These four parts correspond to the principles of the new system construction in Section 3.1.

Among them, cloud teaching can fully display PPT, teachers can easily conduct teaching activities to students by using slides, vivid animations and teaching forms such as videos and stories also greatly relieve students' boredom in the learning process, and at the same time, it is a convenient way for teachers to teach, which is conducive to improving teaching quality; cloud teaching + after-school homework can demonstrate the characteristics of "flipped classroom + mobile learning". At the same time, giving full play to the advantages of "flipped classroom + mobile learning" can also greatly enhance students' learning initiative and close the distance between teachers and students. A good English teaching system using the abovementioned approach is not enough to satisfy the construction principles in Section 3.1 but should also take into account the cultivation of students' other abilities, such as innovative thinking, which can be satisfied by the student-teacher discussion forum. In the student-teacher discussion forum, they can discuss relevant issues in a free-form and open-ended manner, thus making students more creative and open to expressing their opinions and developing their own awareness through the transfer of knowledge in a "silent" manner.

The four parts of the student module correspond to the four parts of the teacher module. These four sections require the teacher to act as a guide and supervisor, leading students through classroom tests, advance study, and participation in teacher-student discussions and question-and-answer sessions. In addition, the teacher should always remember that, "interest is the best teacher", choose the appropriate teaching method in the teaching process and adjust the teaching design or syllabus according to the students' learning results in order to continuously improve the students' learning performance.

In the administrator module, the role of the administrator is mainly a role of an administrator. The administrator module consists of three parts, which are managing accounts, managing courses, and issuing relevant notices and announcements.

4.1. Data Survey. A practical study must be sympathetic to practical and humanistic feelings. The data survey is a good way to explore the reality of the situation. In this paper, the main purpose of using Questionnaire Star is to analyze and investigate the satisfaction survey of students and teachers on English teaching mode. In order to make the experimental results more scientific, this paper makes full use of the convenience of the Internet, directly uses the online survey method of Questionnaire Star, and asks the following questions and generates them in the way of QR code pictures and URLs, etc., to investigate the satisfaction of students and teachers in a university about English teaching mode. The survey was conducted to investigate the satisfaction of students and teachers in a university about the teaching mode of English.

To summarize, in order to carry out the research better and to prove the significance of this paper, a survey on the satisfaction of students and teachers of a vocational college with traditional English teaching was conducted by using a questionnaire. In order to obtain a scientifically significant source of research data, the indicators of the questionnaire are important and crucial. Therefore, this paper has developed the satisfaction indicators of students' satisfaction with the teaching effectiveness of the traditional English classroom system, taking into account the new system construction principles in Section 3.1 and the future development of the students' learning content in the English course in today's multimodal sensing environment. Tables 1 and 2 show the results.

A good teaching system should be built not only at the student level, because teaching is not a matter for students alone, but also a good teaching platform for teachers. Teachers' satisfaction with the teaching system will directly affect the quality of teaching and students' acceptance of knowledge; so, teachers' satisfaction with the teaching system cannot be ignored. Figure 2 shows the survey indicators of teachers' satisfaction in the teaching process about the teaching system affecting teaching quality and so on.

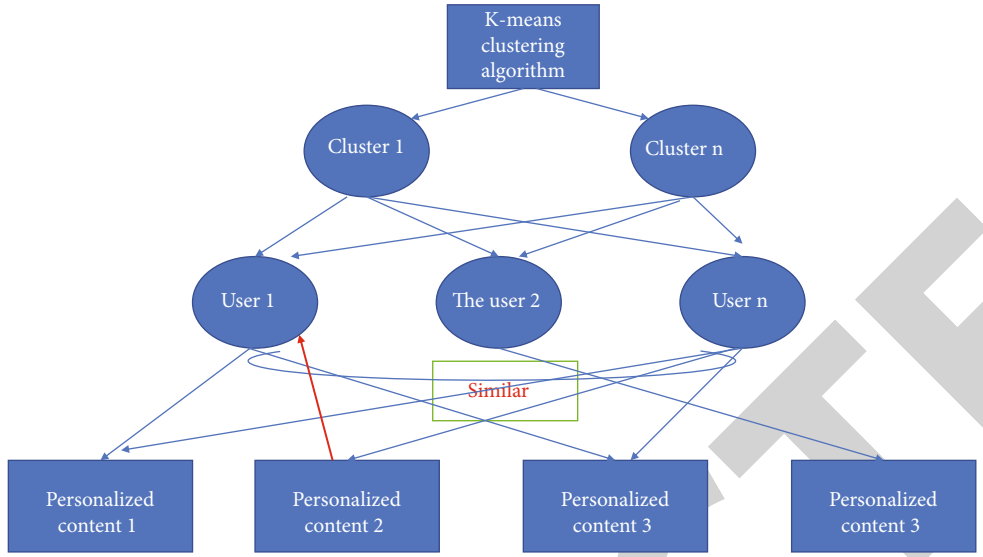

Figure 6: The implementation of the clustering analysis + collaborative filtering recommendation algorithm in the teaching platform.

According to the satisfaction survey indicators of the teaching results based on the English teaching system in Tables 1 and 2 above, 50 students were selected to complete the questionnaire survey in Table 1, 20 teachers were selected to complete the satisfaction survey indicators in Table 2, and the final data survey results are as follows.

As shown in Figures 4 and 5, the results of the survey on students' satisfaction with the process of teaching English under the teaching-based system in a university are presented.

Among them, for Figure 5, B5 does not have this option for the traditional English teaching platform; so, the number of traditional English course teaching platform for B5 is 0 for all three. Why is this indicator not removed? The reason is that it is necessary to set up a discussion forum in the teaching platform, because discussion itself is a good way to learn, and it is not good for students' learning if they do not pay attention to open discussion. Therefore, the new system is designed to include a discussion forum for teachers and students, which may be called an important and indispensable part of teaching and learning.

Therefore, in order to let teachers and students feel the difference between the traditional multimedia-assisted English teaching system and the new system, this paper will use the new system to survey 50 students and 20 teachers again by questionnaire. This paper will then use the new system to investigate the satisfaction level of the old system and the new system to prove the advantages of the new system.

4.2. Construction and Analysis of the New System. Through the analysis and survey in Section 4.1, it is found that students and teachers are not satisfied with the traditional teaching platform, which proves that the construction of the new system has certain scientific significance. In this paper, we analyze the traditional English language teaching model and conclude that the principles of the new system in Section 3.1 are applicable to the current multimodal environment and the diverse developmental characteristics of students. In Section 2.2, it is

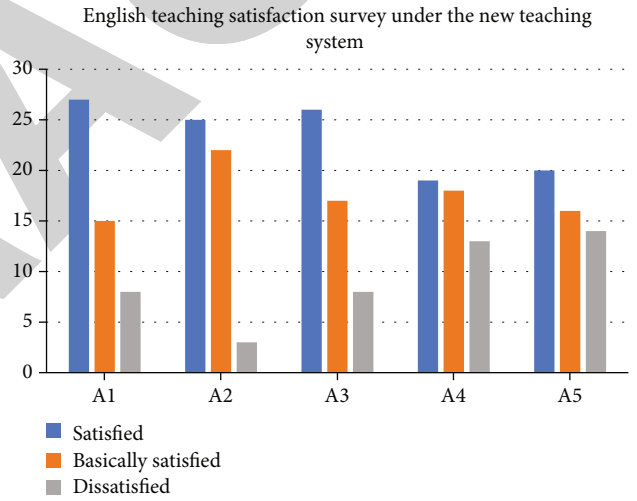

Figure 7: Satisfaction survey of students based on the teaching platform of English courses with the new teaching system.

also emphasized that the interest measure is indispensable if teachers want to improve students' learning performance and teaching quality, but unfortunately, many studies have not fully utilized the measure of "interest is the best teacher" for students' learning. Therefore, this paper introduces a personalized recommendation algorithm in the underlying construction of the teaching platform, taking into account the multimodal environment and students' interest metrics, to recommend personalized content for students and teachers, so that users can better experience immersive learning in the teaching system while cultivating students' independent learning ability and improving the quality of learning.

The framework for building one of the new systems is shown in Figure 3. According to Section 3.3, there are many types of personalized recommendation algorithms, and in order to get better recommendation results and make the experiment more practical, the personalized recommendation

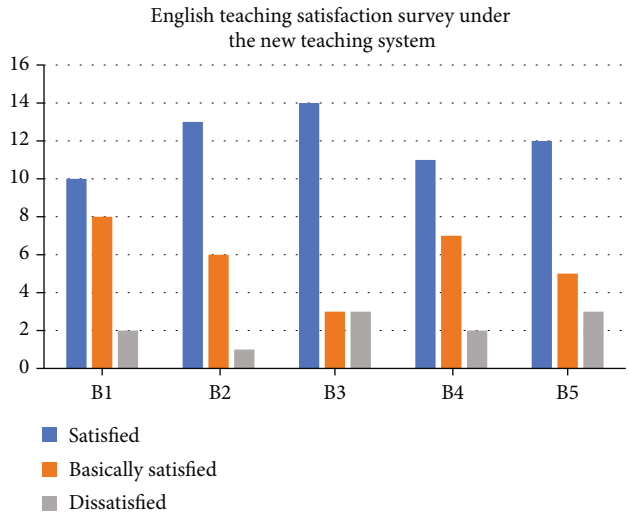

Figure 8: Satisfaction survey of teachers based on the teaching platform of English courses with the new teaching system.

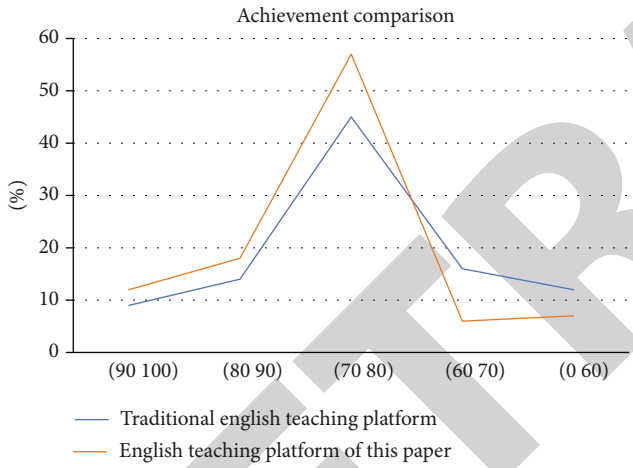

Figure 9: Comparison of the results of the ELT system in this paper and the traditional ELT system statistics.

algorithm adopted in this paper is a combination of clustering algorithm + collaborative filtering algorithm.

According to Section 3.3, the clustering algorithm generally classifies data into clusters by the strength of attributes; so, the idea of clustering reflects the characteristic of "things are clustered, people are divided into groups", and through clustering, data can be processed by machine learning, etc. and finally presented to users with visualized results. Clustering analysis is an unsupervised adaptive learning process, and the data can be sampled and trained without preprocessing the data. However, the results obtained by the clustering algorithm are uncertain; so, it is difficult to analyze and discuss the results using certain evaluation criteria, and therefore, using the clustering analysis algorithm alone is not beneficial for this study. In contrast, collaborative filtering can recommend related things based on what users like and recommend suitable things based on people with common preferences or a combination of the two. Collaborative filtering does not require domain knowledge and does not require specialized domain experience, which is very friendly for building new systems.

To sum up, in this paper, the k-means clustering analysis algorithm is chosen as the preprocessing entrance of the data, and then the collaborative filtering algorithm is used to achieve personalized recommendations for users, of which the implementation process is shown in Figure 6.

Through the discussion in Sections 4.2 and 4.3 above, this paper conducted a survey on the satisfaction of 50 students and 20 teachers with the same indexes as the new system. The results of these surveys are shown in Figures 7 and 8.

By analyzing Figures 7 and 4, it can be seen that the new teaching system has increased the index of each index compared with the old teaching system, which fully indicates that the system studied in this paper is acceptable to students and can improve students' learning efficiency and has certain significance for students' future employment. Comparing Figures 5 and 8, it can be seen that the new system of this paper is also highly satisfied by teachers, both in terms of students' acceptance and learning efficiency in the classroom, as well as in terms of answering questions and discussions after the class, which shows that the new system of this paper has certain application value.

Finally, in order to better prove the impact of the new system on learning effect, this paper counted the percentage of students' performance in two classes, one of which used the teaching mode under the traditional teaching system and the other used the new system of this paper, and finally organized the data to get the graph shown in the figure below.

The English teaching system proposed in this paper can effectively improve students' learning performance. The number of students in the two test classes selected in this paper is 50, and the percentages of the results are shown in the following figure: the test paper in this paper is full of 100 points, in which the results are calculated mathematically according to each segment, and the final figure is obtained in the following figure. Observing the figure below, it can be seen that the teaching system proposed in this paper increases or decreases the number of students regardless of the score band, in which the effect of improving in the score band of (70 80) is the most obvious, as shown in Figure 9.

5. Conclusion

This paper investigates the construction of a multimedia-assisted English teaching system based on a multimodal environment. The personalized recommendation algorithm is introduced in the process of system construction, and the new system studied in this paper is proved to have certain pedagogical significance and can greatly improve students' performance by means of questionnaires and performance comparison. However, there are still some shortcomings in this paper, such as the administrator module is a coordinator, which manages and controls the operation status of the whole system and is a very important part of the system in this paper. If the administrator account is stolen, then the information of teachers and students of the whole teaching system will be greatly threatened.

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Research Article

Stabilization and Ecological Risk Evaluation of Heavy Metals in Farmland Soils by Addition of Attapulgite Modified with Phosphates

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Purpose. Attapulgite was modified by sodium dihydrogen phosphate, oxalic acid-activated phosphate rock powder, potassium dihydrogen phosphate, calcium superphosphate, ammonium dihydrogen phosphate, and fused calcium-magnesium phosphate and used in the remediation of Cd, Zn, and Ni. *Materials and Methods*. Attapulgite was modified by six kinds of phosphate (ratio: 1 : 2), and the improvement effect of passivation material on soil polluted by cadmium, zinc, and nickel was determined. $CaCl_2$-extractable and toxicity characteristic leaching procedure- (TCLP-) extractable Cd, Zn, and Ni were measured in order to estimate the bioavailability and the stabilization efficiency. Pot experiment was conducted to study the enrichment and transport ability of Cd, Zn, and Ni in corn. The ecological risk and ecological toxicity of soil environment were evaluated by calculating SE_m, ERI_m, CRI_m, and BUF. *Results and Discussion*. Compared with ATP, passivation materials AAPR, AMRP, ASSP, AMAP, and AFMP can improve the stability of CD, Zn, and Ni in soil, and AAPR has the best effect. Compared with CK treatments and ATP treatments, the concentrations of TCLP-extractable Cd decreased by 30.80% and 24.72%, respectively, the concentrations of TCLP-extractable Zn decreased by 15.50% and 11.18%, respectively, and the concentrations of TCLP-extractable Ni decreased by 31.34% and 23.20%, respectively. Compared with ATP treatments, CRI, $BUF\text{-}_{Cd}$, $BUF\text{-}_{Ni}$, and $BUF\text{-}_{Zn}$ decreased by 24.67%, 52.88%, 78.73%, and 41.18%, respectively, in the AAPR treatments. *Conclusions*. Phosphate-modified attapulgite can effectively improve the stability of heavy metals in soil and reduce the migration of heavy metals. In the soil polluted by Cd, Zn, and Ni, the passivation effect of AAPR is the best. Therefore, AAPR can be used as an economical, safe, and effective passivation material to improve Cd-, Zn-, and Ni-contaminated soil, which would have a high utilization value in field applications.

1. Introduction

In recent years, with the continuous emergence of heavy metal pollution in farmland soil and the aggravation of pollution degree [1], the fact that how to reduce the transfer of heavy metals from soil to crops without affecting farmland crop cultivation has become an urgent problem to be solved. Therefore, heavy metal chemical passivation technology becomes the main research method [2]. At present, passivation materials mainly enhance the adsorption capacity through exploring and modifying all kinds of clay minerals, biological state, industrial by-products, phosphate minerals, etc. [3] and transforming the reduced, oxidized, and extractable heavy metals in the soil into residue, which are fixed in the improver to reduce the migration in the soil [4–6].

As a kind of clay mineral, attapulgite has porous crystal structure and contains tetrahedral layer alloyed by longitudinal chain [7]. This kind of hydrated aluminosilicate mineral is composed of parallel zone of 2 : 1 layer [8]. It has moderately high structural charge and medium specific surface

area and can adsorb heavy metals in the crystal structure, thus playing a good role in passivating heavy metals [9]. Studies have shown that adding 4% attapulgite can reduce 92% lead, 77% copper, and 76% cadmium in sandy soil [8]. Tan et al. have shown that by adding appropriate amount of attapulgite clay minerals, the average repair rates of Zn and Cd can reach 26.15% and 34.92%, respectively [10]. After studying the remediation effect of attapulgite on soil and rice and analyzing its potential immobilization mechanism, Liang et al. concluded that the concentration of cadmium extracted by hydrochloric acid, TCLP, calcium chloride, alkali hydrolyzable nitrogen, and hydrobromate could be significantly reduced by adding different amounts of attapulgite, resulting in a significant decrease in the concentration of cadmium in brown rice [11]. The results showed that attapulgite has a good passivation effect on heavy metals.

As a widely used passivator of heavy metals in soil, phosphate can effectively fix cadmium and zinc in soil by coprecipitation, ion exchange, and complexation, thus reducing the transfer of heavy metals to plants [12]. Zhang et al. showed that the leaching concentration of zinc and cadmium in soil with 2-10% APR, decreased by 15-52% and 12-62%, respectively, which had a good passivation effect on cadmium and zinc in soil [13]. The use of hydroxyapatite by Yu et al. could make the curing efficiency of cadmium reach 52.7% [14]. Xiuli et al. found that the application of potassium dihydrogen phosphate, diammonium hydrogen phosphate and zeolite and the combined application of zeolite and dipotassium hydrogen phosphate, zeolite, and diammonium hydrogen phosphate reduced the soil available Cd content by 25.2%, 51.7%, 21.6%, 46.8%, 38.6%, 61.4%, and 34.1%, respectively [15].

To sum up, attapulgite and phosphate can passivate cadmium, zinc, and nickel in soil, but the extensive use of phosphate will cause soil eutrophication and the imbalance of nutrient elements in soil and cause secondary pollution of the environment; at the same time, the cost is more higher. As a natural clay mineral, attapulgite has the advantages of high output, low price, and no secondary pollution. Therefore, it is an effective way to combine phosphate with attapulgite to improve the efficiency of attapulgite passivation of heavy metals. Based on aforesaid view, in the experiment, a kind of phosphate which has the best passivation effect on heavy metals in soil was selected and loaded attapulgite with a variety of phosphates, thus providing a theoretical basis for attapulgite to be put into production as a passivator in the later stage.

2. Materials and Methods

2.1. Soil. Farmland soil sample was collected at 0-20 cm depths from arable land in Silong Town (36° 29′ 26.2″ N, 104° 16′ 57.4″ E), Gansu province, northwest China. The main crop in the area is maize, and the main source of pollution is the erosion of waste water from a nearby chemical factory into the soil. Extracted sample was air-dried and then ground to pass through a 2 mm sieve for the pot trial. The physical and chemical properties of the soil are shown in Table 1.

Table 1: Chemical properties of the initial soil.

Properties	Value
Soil pH	7.41
Electrical conductivity (EC) (mS/cm^{-1})	2.16
Cation exchange capacity (CEC) ($cmol/kg^{-1}$)	73.92
Organic matter (OM)(%)	1.2
Soil available N (mg/kg^{-1})	34.99
Soil available P (mg/kg^{-1})	69.58
Soil available K (mg/kg^{-1})	423.99
Total concentration of Cd (mg/kg^{-1})	19.48
Total concentration of Zn (mg/kg^{-1})	383.51
Total concentration of Ni (mg/kg^{-1})	82.39

2.2. Attapulgite-Modified Phosphate. The attapulgite used in the experiment came from Gansu Hanxing Environmental Protection Co., Ltd. It has a fiber bundle structure and is mainly composed of quartz, dolomite, muscovite, chlorite, feldspar, and other minerals [16, 17]. Before using attapulgite, it needs to be further purified and acidified to achieve a better passivation effect. The specific methods are as follows: put a certain amount of attapulgite into 1 L beaker and stir with deionized water. After stirring evenly, the attapulgite in the beaker was placed for 24 hours, after the attapulgite in the beaker was obviously delaminated, removed the impurities such as quartz at the bottom of the beaker, and thus obtained the purified attapulgite. Added 3 mol/L hydrochloric acid to the purified attapulgite for 30 min was oscillated with 200 r/min, then filtered, then washed repeatedly to neutral with deionized water, dried in a drying oven at 105°C, ground, and passed through 100 mesh sieve to obtain acid-activated attapulgite (ATP). Sodium dihydrogen phosphate, oxalic acid, ground phosphate rock, potassium dihydrogen phosphate, calcium superphosphate, ammonium dihydrogen phosphate, and fused calcium-magnesium phosphate were purchased from Guangdong Guanghua Science and Technology Co., Ltd., all of which were analytically pure. The preparation method of oxalic acid-activated phosphate rock powder is as follows: the oxalic acid and phosphate rock powder of 0.5 mol/L were mixed at the ratio of 10 : 1, cultured at 28°C for 6 days, dried at 60°C [18], ground and sifted through 100-mesh sieve, and set aside for further usage.

In this experiment, sodium dihydrogen phosphate, oxalic acid activated phosphate rock powder, potassium dihydrogen phosphate, calcium superphosphate, ammonium dihydrogen phosphate, and fused calcium-magnesium phosphate and attapulgite were mixed into beakers according to the proportion of 1 : 2, and then adding a certain amount of deionized water (solid-liquid ratio: 1 : 10), stirring for 2 hours, then ultrasonic 30 mins, drying at 80°C pyrolysis of the dried material in muffle furnace (KSW-6-12A) at 400°C for 2 hours, and then reduced to room temperature, dried, and sealed.

The attapulgite was mixed with sodium dihydrogen phosphate, oxalic acid-activated phosphate rock powder,

potassium dihydrogen phosphate, calcium superphosphate, ammonium dihydrogen phosphate, and fused calcium-magnesium phosphate in a mass ratio of 2 : 1. The modification was carried out for 2 hours under the condition of solid-liquid ratio of 1 : 10 and stirring speed of 500 r·min^{-1}. Then, six kinds of mixed materials were put into ultrasonic cleaner (KH-500DV). Under the condition of 60°C and ultrasonic frequency 40 KHz, ultrasonic 30 min was put into a constant temperature blast drying box, dried at 70°C, then cooled to room temperature and ground through a 100-mesh sieve. Finally, six kinds of dried mixed materials were put into muffle furnace (KSW-6-12A), pyrolyzed at 400°C for 2 hours, and then, reduced to room temperature, that is, different phosphate-modified attapulgite passivation materials were prepared, which were marked AMSP, AAPR, AMRP, ASSP, AMAP, and AFMP, respectively.

2.3. Incubation Experiment. 1.5 kg of soil samples was placed in a plastic basin, and the well-prepared passivating materials were evenly added into the basin according to 4% of the soil weight. In this experiment, there were 8 groups of treatments: (1) control group CK, (2) attapulgite treatment group ATP, (3) attapulgite treatment group modified with sodium dihydrogen phosphate AMSP, (4) attapulgite treatment group modified with oxalic acid activated phosphate powder AAPR, (5) attapulgite treatment group modified with potassium hydrogen phosphate ASSP, (6) attapulgite treatment group modified with calcium superphosphate ASSP, (7) attapulgite treatment group modified with ammonium dihydrogen phosphate AMAP, and (8) attapulgite treatment group modified with fused calcium-magnesium phosphate AFMP. Deionized water was added to each treatment, and the field capacity was kept at 70%. The soil was passivated at room temperature for 30 days, and three replicates were set for each treatment. The physical and chemical properties of soil and the content of bioavailable Cd, Zn, and Ni were determined.

2.4. Pot Experiment. Ten corn seeds were evenly scattered in the passivated soil of each pot and randomly placed in the artificial climate incubator to grow. After the corn germinated, the seedlings reached 5 per pot and continued to grow for 60 days. During the growth of corn, the same quality of deionized water was added to each pot of soil by weighing every other day. The aboveground and underground parts of the harvested corn samples were separated, and the impurities left on the plant surface were washed with deionized water, and the root length and stem length of each maize seedling were measured by micrometer. The fresh weight of the above ground and underground parts of the corn samples was determined. After the determination of fresh weight, put the sample in the oven, first kill 30 min at 105°C, and then dry at 70°C to constant weight. After determining the dry matter mass of the above ground and underground parts, respectively, the dry matter is ground and sifted through 100 mesh and then stored in a sealed bag.

2.5. Analytical Methods. Soil pH was measured with the soil/water ratio of 1 : 2.5 (w/v) using a pH meter (Lei ci pH3C,Shanghai); soil electric conductivity was measured with the soil/water ratio of 1 : 5 (w/v) using a conductivity meter (Lei ci pH3C, Shanghai); soil cation exchange capacity was determined by barium chloride-sulfuric acid forced exchange method, and soil organic matter was determined by potassium dichromate volumetric method. Available N, available K, and available P were determined by alkali hydrolysis diffusion method, NH_4OAC extraction flame photometer method, and sodium bicarbonate extraction-molybdenum-antimony resistance colorimetric method, respectively [19]. The total amount of heavy metals in soil was digested by HCl-HNO_3-HF-$HClO_4$ ($v : v : v : v = 1 : 1 : 0.5 : 1$) method and determined by atomic absorption spectrophotometer (AAS, Persee TAS-990). The contents of heavy metals in the aboveground and underground parts of maize were determined by HNO_3–$HClO_4$ digestion, and the contents of cadmium and zinc in the samples were determined by atomic absorption spectrophotometer (AAS, PerseeTAS-990).

2.6. Measurement of Bioavailability of Heavy Metals. The bioavailable Cd, Zn, and Ni in soil were determined by atomic absorption spectrophotometer after extracted with $CaCl_2$ extract and TCLP extract [20]. The specific methods are as follows: put 1 g of dried soil sample into a centrifuge tube, add $CaCl_2$ solution of 25 mL0.1 mol/L or 20 mL TCLP extract, shake for 2 hours or 18 hours, respectively, at room temperature, centrifuge 15 min at 4000 rpm/min, extract the supernatant through 0.45um filter paper, and determine the concentration of Cd, Zn, and Ni in the filtrate by atomic absorption spectrophotometer (AAS, PerseeTAS-990).

2.7. Evaluation of Ecological Risk and Ecotoxicity. Stabilization efficiency (SE_m) of heavy metal (m) was calculated by Equation (1), where C_{mck} is the extractable concentration of heavy metal in the control soil (CK), and C_m is the extractable concentration of heavy metal in the amended soil [21, 22].

$$SE_m = \frac{C_{mck} - C_m}{C_{mck}} \times 100\%. \quad (1)$$

Ecological risk index (ERI_m) of heavy metal (m) can be calculated by Equation (2) and was usually employed to assess the ecological risk of heavy metals in soil, sludge, biochar, and other materials, where C_m is the total concentration of heavy metal from the soil, and C_{mi} is the extractable concentration of heavy metal from the treatments using i kind extractable method. ERI_m had been widely used in the environment science for heavy metal toxicity assessment. ERI_m assesses the availability of heavy metals by applying the percentage of heavy metals present in bioavailability content. Five classification of ERI_m were showed as no risk, ERI_m lower than 1%; low risk, ERI_m in the range of 1~10%; medium risk, ERI_m in the range of 10~30%; high risk, ERI_m in the range of 30~50%; and very high risk, ERI_m higher than 50% [23].

$$ERI_{mi} = \frac{C_{mi}}{C_m} \times 100\%. \quad (2)$$

The comprehensive risk index (CRI_m) for individual metal (m) may be calculated by Equation (3) and used to evaluate the ecological risk based on n kind extractable methods. T_m was the toxic coefficient of the individual heavy metal, the values of T_m for Zn, Cr, Cu, Ni, Pb, and Cd were in the order of 1, 2, 5, 6, 5, and 30 [24], and the comprehensive risk index (CRI) for some kind of stabilizing material or method can be gotten by Equation (4) based on k kind heavy metals:

$$CRI_m = \sum_{i=1}^{n} ERI_{mi} \times 100\%, \quad (3)$$

$$CRI = \sum_{i=1}^{k} T_m \times CRI_m \times 100\%. \quad (4)$$

Bioconcentration factor (BCF) and transfer factor (TF) was used to evaluate the transfer characteristics of heavy metals from the soil to the plant [25–27] as

$$BCF = \frac{C_{root}}{C_{soil}} * 100\%, \quad (5)$$

$$TF = \frac{C_{shoot}}{C_{root}}. \quad (6)$$

The ability of plant to translocate and take up heavy metals was assessed using the biological uptaking factor (BUF) which was calculated by Equation (7) [28], where B_{root} was the biomass of root and B_{shoot} was the biomass of shoot.

$$BUF = \frac{C_{shoot} \times B_{shoot} + C_{root} \times B_{root}}{B_{root}} \times 100\%. \quad (7)$$

2.8. Statistical Analysis. All results in this study were presented as the mean values of three replicates and standard deviations, and the data were analyzed using one-way analysis of variance (ANOVA) and the least significant difference (LSD) test with SPSS 22.0 statistics software, taking $P \leq 0.05$ as the significance level. The graphs and the tables were drawn by Origin 2019 and Microsoft Excel 2016, respectively.

3. Results and Discussion

3.1. Physiochemical Traits. The effects of attapulgite modified with different phosphates on soil physical and chemical properties were shown in Table 2. The soil pH of 8 treatments were 7.41, 7.50, 7.26, 7.60, 6.81, 6.45, 6.28, and 7.00, respectively. Compared with CK treatments, the addition of ATP treatments and AAPR treatments increased soil pH by 0.09 and 0.19, respectively. AMRP treatments, ASSP treatments, AMAP treatments, and AFMP treatments decreased soil pH by 0.15, 0.6, 0.96, 1.13, and 0.41, respectively. The addition of passivation materials also changed the soil EC in the range of 2.28-1.90 ms/cm^{-1}, in which the AAPR treatments increased the soil EC by 0.12 ms/cm^{-1} to 2.28 ms/cm^{-1}, and the soil EC value decreased slightly compared with CK treatments with the addition of other passivators, which decreased by 0.15 ms/cm^{-1}, 0.26 ms/cm^{-1}, 0.07 ms/cm^{-1}, 0.08 ms/cm^{-1}, 0.11 ms/cm^{-1}, and 0.014 ms/cm^{-1}, respectively. However, there was no significant difference between 8 treatments ($P < 0.05$). With the addition of passivation materials, soil CEC in different treatments showed an increasing trend compared with CK treatments, with an increase range of 1.15 cmol/kg^{-1} to 91.75 cmol/kg^{-1}. Especially in the AAPR treatments, the soil CEC value increased by 91.75 cmol/kg^{-1} compared with CK treatments, reaching 196.67 cmol/kg^{-1}. There was significant difference between AAPR treatments and other treatments ($P < 0.05$), and AMSP treatments, AMRP treatments, AMAP treatments, and AFMP treatments also showed significant differences compared with CK treatments ($P < 0.05$).

N, P, and K are necessary nutrient elements for plant growth. The content of N, P, and K in soil directly determines the biomass of soil plants. Phosphate, as a kind of fertilizer containing phosphorus, will greatly change the content of N, P, and K in soil. It can be seen from Table 2 that the contents of available P and K in soil increased in varying degrees after the addition of phosphate-modified attapulgite. Among them, the content of soil available P in AMSP treatments, AAPR treatments, AMRP treatments, ASSP treatments, AMAP treatments, and AFMP treatments increased by 152.91 mg/kg^{-1}, 211.20 mg/kg^{-1}, 184.87 mg/kg^{-1}, 147.84 mg/kg^{-1}, 183.66 mg/kg^{-1}, and 180.09 mg/kg^{-1} compared with CK treatments, respectively. Compared with CK treatments, the content of soil available K increased by 45.84 mg/kg^{-1}, 130.98 mg/kg^{-1}, 517.43 mg/kg^{-1}, 117.85 mg/kg^{-1}, 78.55 mg/kg^{-1}, and 75.29 mg/kg^{-1}, respectively. Compared with CK treatments, the content of soil available N in AAPR treatments, ASSP treatments, AMAP treatments, and AFMP treatments increased by 6.33 mg/kg^{-1}, 5.94 mg/kg^{-1}, 44.34 mg/kg^{-1}, and 22.66 mg/kg^{-1}, while that in AMSP treatments and AMRP treatments decreased by 0.66 mg/kg^{-1} and 0.65 mg/kg^{-1}, respectively. In the ATP treatments, the contents of available P and available K decreased by 2.96 mg/kg^{-1} and 42.58 mg/kg^{-1}, respectively, compared with CK treatments, and the content of available N increased by 1.06 mg/kg^{-1} compared with CK treatments. The contents of soil available P, available K, and available N in AMSP treatments, AAPR treatments, AMRP treatments, ASSP treatments, AMAP treatments, and AFMP treatments were significantly higher than those in CK treatments and ATP treatments, and the contents of soil available N in AAPR treatments, ASSP treatments, AMAP treatments, and AFMP treatments were significantly higher than those in CK treatments and ATP treatments ($P < 0.05$). According to the analysis of variance of soil available P, available K, and available N in soil, the contents of soil available P and K in AAPR treatments, ASSP treatments, AMAP treatments, and AFMP treatments were significantly higher than those in CK treatments and ATP treatments ($P < 0.05$).

3.2. Bioavailability of Heavy Metals. Figure 1 indicated that the concentrations of $CaCl_2$-extractable Cd, Zn, and Ni in the soil decreased to varying degrees. Compared with CK

Table 2: The pH, CEC (cmol/kg), EC (ms/cm), and available P, K, and N (mg/kg^{-1}) of stabilized soils.

Treatments	CK	ATP	AMSP	AAPR	AMRP	ASSP	AMAP	AFMP	F-value
PH	7.41 ± 0.07b	7.50 ± 0.09ab	7.26 ± 0.07c	7.60 ± 0.08a	6.81 ± 0.01e	6.45 ± 0.01f	6.28 ± 0.04g	7.00 ± 0.05d	218.556***
EC	2.16 ± 0.05ab	2.01 ± 0.04bc	1.90 ± 0.05c	2.28 ± 0.12a	2.09 ± 0.17b	2.07 ± 0.01b	2.05 ± 0.03b	2.15 ± 0.01ab	4.495***
CEC	118.25 ± 11.15de	127.90 ± 15.77d	175.16 ± 6.15ab	196.67 ± 4.26a	137.63 ± 9.61cd	94.74 ± 9.42e	160.75 ± 29.91bc	166.93 ± 0.41b	18.815***
Available P	71.99 ± 5.31b	69.03 ± 3.84b	224.90 ± 18.43a	283.19 ± 27.31a	256.86 ± 91.72a	219.83 ± 46.93a	255.65 ± 1.81a	252.08 ± 2.55a	14.695***
Available K	437.09 ± 11.34e	394.51 ± 9.85f	482.92 ± 19.67d	568.06 ± 5.70b	954.52 ± 0.09a	554.94 ± 31.57b	515.64 ± 11.35c	512.38 ± 0.02c	402.646***
Available N	24.89 ± 0.20de	25.95 ± 0.51d	24.23 ± 0.32e	31.22 ± 0.67c	24.24 ± 0.49e	30.83 ± 0.69c	69.23 ± 0.69a	47.55 ± 1.71b	1221.227***

Values were means ± SD ($n = 3$). The same letters within a line indicated no significant differences at $P < 0.05$. ***Statistical significance at 0.01.

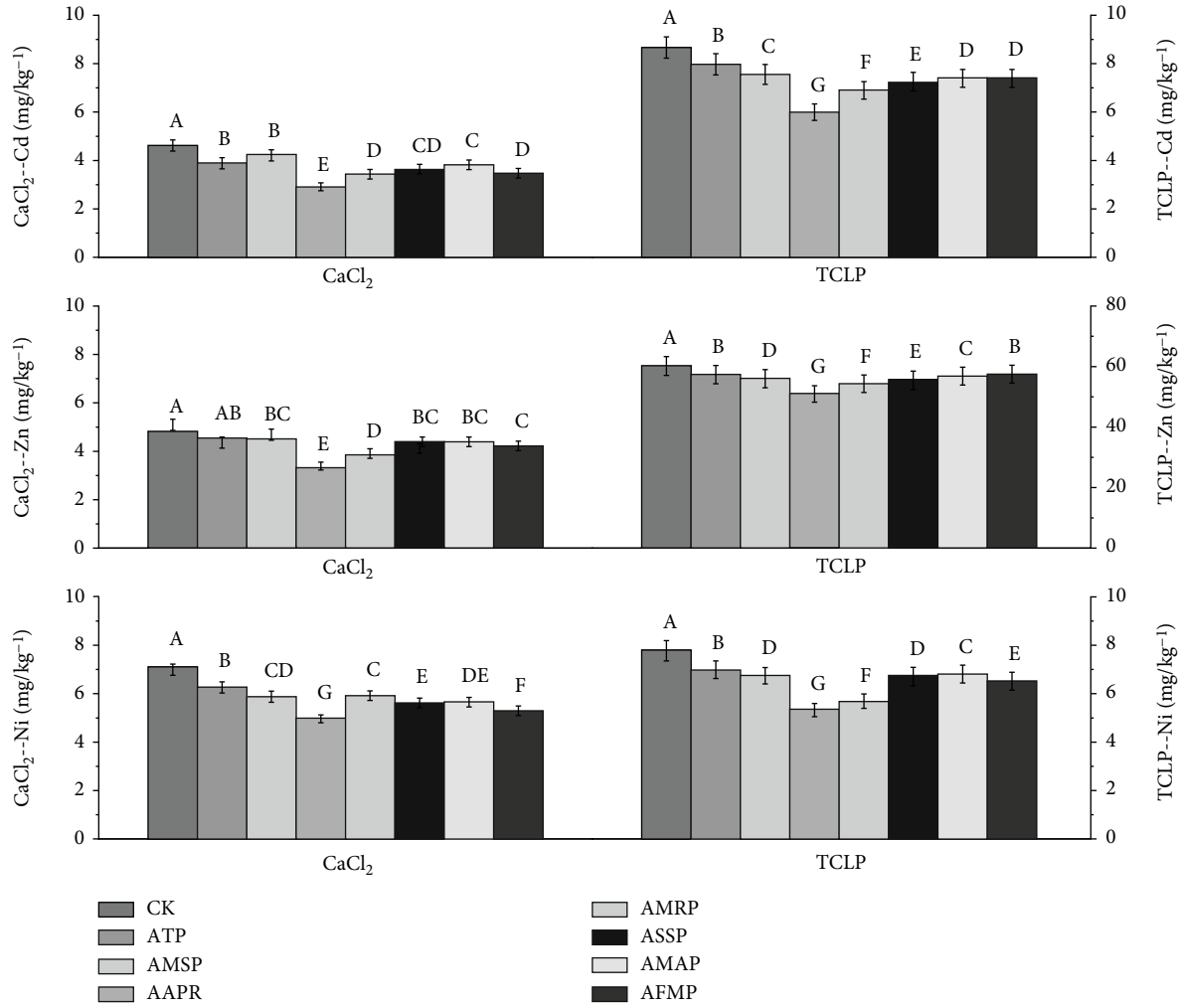

Figure 1: Bioavailability contents (mg/kg^{-1}) of heavy metals in stabilized soils. Data were means ± SD ($n = 3$). Column with the same letter has no significant differences between treatment at $P < 0.05$ according to the least significant difference (LSD) test.

treatments, concentrations of $CaCl_2$-extractable Cd in the ATP treatments, AMSP treatments, AAPR treatments, AMRP treatments, ASSP treatments, AMAP treatments, and AFMP treatments decreased by 0.72 mg/kg^{-1}, 0.4 mg/kg^{-1}, 1.71 mg/kg^{-1}, 1.18 mg/kg^{-1}, 0.99 mg/kg^{-1}, 0.8 mg/kg^{-1}, and 1.15 mg/kg^{-1}, respectively. The concentrations of $CaCl_2$-extractable Cd in the soil treated with passivator were significantly different from that of CK ($P < 0.05$). Compared with CK treatments, when ATP, AMSP, AAPR, AMRP, ASSP, AMAP, and AFMP were applied into the soil, concentrations of $CaCl_2$-extractable Zn decreased by 0.27 mg/kg^{-1}, 0.31 mg/kg^{-1}, 1.49 mg/kg^{-1}, 0.97 mg/kg^{-1}, 0.42 mg/kg^{-1}, 0.43 mg/kg^{-1}, and 0.6 mg/kg^{-1}, respectively. Except for ATP treatments, the concentrations of soil available Zn in the other six treatments were significantly different from that in CK treatments ($P < 0.05$). Compared with CK treatments, concentrations of $CaCl_2$-extractable Ni in the ATP treatments, AMSP treatments, AAPR treatments, AMRP treatments, ASSP treatments, AMAP treatments, and AFMP treatments decreased by 0.83 mg/kg^{-1}, 1.22 mg/kg^{-1}, 2.10 mg/kg^{-1}, 1.18 mg/kg^{-1}, 1.48 mg/kg^{-1}, 1.42 mg/kg-^{1}, and 1.81 mg/kg^{-1}, respectively. After the attapulgite was modified by various phosphates, except for AMSP treatments, the concentrations $CaCl_2$-extractable Cd, Zn, and Ni in attapulgite modified by phosphate was lower than that of attapulgite. Among them, the effect of AAPR treatments was the best, and the contents of Cd, Zn, and Ni decreased by 0.99 mg/kg^{-1}, 1.22 mg/kg^{-1}, and 1.27 mg/kg^{-1}, respectively, compared with ATP treatments, and reached a significant difference compared with other treatments ($P < 0.05$).

Figure 1 indicated that the concentrations of TCLP-extractable Cd, Zn, and Ni in soil CK treatments were 8.67 mg/kg^{-1}, 60.06 mg/kg^{-1}, and 7.78 mg/kg^{-1}, respectively. When ATP, AMSP, AAPR, AMRP, ASSP, AMAP, and AFMP were applied into the soil, the concentrations of TCLP-extractable Cd, Zn, and Ni decreased in varying degrees. Compared with CK treatments, the concentrations of TCLP-extractable Cd decreased by 0.70 mg/kg^{-1}, 1.11 mg/kg^{-1}, 2.67 mg/kg^{-1}, 1.76 mg/kg^{-1}, 1.44 mg/kg^{-1}, 1.28 mg/kg^{-1}, and 1.26 mg/kg^{-1}, respectively. The concentrations of TCLP-extractable Zn decreased by 2.92 mg/kg^{-1}, 4.22 mg/kg^{-1}, 9.31 mg/kg^{-1}, 5.97 mg/kg^{-1}, 4.63 mg/kg^{-1},

3.46 mg/kg^{-1}, and 2.92 mg/kg^{-1}, respectively. The concentrations of TCLP-extractable Ni decreased by 0.83 mg/kg^{-1}, 1.05 mg/kg^{-1}, 2.44 mg/kg^{-1}, 2.12 mg/kg^{-1}, 1.06 mg/kg^{-1}, 0.99 mg/kg^{-1}, and 1.27 mg/kg^{-1}, respectively. Compared with ATP treatments, the concentrations of TCLP-extractable Cd, Zn, and Ni under the influence of AMSP treatments, AAPR treatments, AMRP treatments, ASSP treatments, AMAP treatments, and AFMP treatments decreased by 5.14%-24.72%, 2.28%-11.18%, and 2.42%-23.20%, respectively. Among them, the effect of AAPR treatments were the best. Compared with CK treatments and ATP treatments, the concentrations of TCLP-extractable Cd decreased by 30.80% and 24.72%, respectively, the concentrations of TCLP-extractable Zn decreased by 15.50% and 11.18%, respectively, and the concentrations of TCLP-extractable Ni decreased by 31.34% and 23.20%, respectively. There was significant difference between AAPR treatments and other treatments ($P < 0.05$).

3.3. Evaluation of Ecological Risk. Figure 2 shows that under the condition of $CaCl_2$ extraction, the stabilization efficiency of Cd, Zn, and Ni in the untreated soil were 76.28%, 98.75%, and 91.41%, respectively. When ATP, AMSP, AAPR, AMRP, ASSP, AMAP, and AFMP were applied into the soil, the stabilization efficiency of Cd, Zn, and Ni were gradually enhanced. Compared with CK treatments, the stabilization efficiency of Cd, Zn, and Ni in the ATP treatments, AMSP treatments, AAPR treatments, AMRP treatments, ASSP treatments, AMAP treatments, and AFMP treatments were increased 3.70, 2.05, 8.78, 6.06, 5.08, 4.11, and 5.90 percentage points, respectively. The stabilization efficiency of Zn were increased 0.07, 0.08, 0.39, 0.25, 0.11, 0.11, and 0.16 percentage points, respectively. The stabilization efficiency of Ni were increased 1.0, 1.48, 2.55, 1.43, 1.80, 1.72, and 2.20 percentage points, respectively.

Under the condition of TCLP extraction, the stabilization efficiency of Cd, Zn, and Ni in the untreated soil were 55.49%, 84.34%, and 90.56%, respectively. Compared with CK treatments, the stabilization efficiency of Cd in the ATP treatments, AMSP treatments, AAPR treatments, AMRP treatments, ASSP treatments, AMAP treatments, and AFMP treatments were increased 3.59, 5.70, 13.71, 9.04, 7.39, 6.57, and 6.47 percentage points, respectively. The stabilization efficiency of Zn were increased 0.76, 1.10, 2.43, 1.56, 1.21, 0.90, and 0.76 percentage points, respectively. The stabilization efficiency of Ni were increased 1.00, 1.27, 2.96, 2.58, 1.28, 1.21, and 1.55 percentage points, respectively. In general, passivation materials play a certain role in the stabilization efficiency of Cd, Zn, and Ni in soil, especially AAPR treatments can greatly improve the stabilization efficiency of Cd, Zn, and Ni in soil.

Table 3 shows that in different treatments, the ERIm-$CaCl_2$ of Cd, Zn, and Ni in the soil is 23.72%-14.94%, 1.25%-0.86%, and 8.60%-6.04%, respectively. Among them, the ecological risk index of Cd is in the range of 10-30%, which belongs to medium risk, and the ecological risk index of Zn and Ni is in the range of 1-10%, which belongs to low risk. The ERIm-TCLP of Cd, Zn, and Ni in the soil is 44.53%-30.79%, 15.66%-13.23%, and 9.44%-6.49%, respectively. Among them, the ecological risk index of Cd is in the range of 30-50%, which belongs to high risk, the ecological risk index of Zn is in the range of 10-30%, which belongs to medium risk, and the ecological risk index of Ni is in the range of 1-10%, which belongs to low risk. The ecological risk degree of the three heavy metals is Cd > Ni > Zn, respectively. Among the different treatments, the effect of AAPR treatments is the best, and the ecological risk index is the lowest.

3.4. Evaluation of Ecotoxicity. Figure 3 shows that the concentrations of Cd and Zn in corn vary greatly under different treatments. The highest contents of Cd and Zn in underground parts were CK treatments, which were 19.21 mg/kg^{-1} and 355.66 mg/kg^{-1}, and the lowest was AAPR treatments, which is 8.37 mg/kg^{-1} and 217.95 mg/kg^{-1}, respectively. The highest concentrations of Cd and Zn in aboveground parts was CK treatments, which were 11.06 mg/kg^{-1} and 245.62 mg/kg^{-1}, and the lowest was AAPR treatments, which was 2.25 mg/kg^{-1} and 62.34 mg/kg^{-1}, respectively. Compared with CK treatments, the enrichment of Cd and Zn in different parts of corn could be reduced by adding passivator. Under the ATP treatments, AMSP treatments, AAPR treatments, AMRP treatments, ASSP treatments, AMAP treatments, and AFMP treatments, the concentrations of Cd in the underground part of corn were decreased by 15.24%, 17.01%, 56.40%, 46.36%, 36.67%, 41.46%, and 42.59%, respectively. The concentrations of Cd in the aboveground part of maize decreased by 43.67%, 45.72%, 79.69%, 64.41%, 63.05%, 68.60%, and 66.49% compared with CK treatments, respectively. Compared with CK treatments, the concentrations of Zn in underground parts of corn decreased by 14.31%, 15.58%, 38.72%, 29.62%, 20.74%, 27.41%, and 29.79%, respectively. The concentrations of Zn in aboveground parts of corn decreased by 36.57%, 43.05%, 74.62%, 64.67%, 53.15%, 60.19%, and 63.21% compared with CK treatments, respectively. In terms of biological concentration factor and translocation factor, the biological concentration factors of Cd and Zn in CK treatments were 0.99 and 0.93, respectively, and the translocation factors were 0.58 and 0.69, respectively. The biological concentration factor and translocation factor of corn Cd and Zn decreased after adding passivation materials. In the ATP treatments, AMSP treatments, AAPR treatments, AMRP treatments, ASSP treatments, AMAP treatments, and AFMP treatments, the biological concentration factor of Cd decreased by 0.15, 0.17, 0.56, 0.46, 0.36, 0.41, and 0.42, respectively. The translocation factor of Cd decreased by 0.19, 0.20, 0.31, 0.19, 0.24, 0.27, and 0.24, respectively. The biological concentration factor of Zn decreased by 0.13, 0.15, 0.36, 0.28, 0.20, 0.26, and 0.28, respectively. The translocation factor of Zn decreased by 0.18, 0.23, 0.41, 0.35, 0.28, 0.31, and 0.33, respectively.

The accumulation of Ni in maize is different from that of Cd and Zn. Figure 3 shows that the concentrations of Ni in the underground and aboveground part of corn are 32.24 mg/kg^{-1} and 15.69 mg/kg^{-1}. When ATP, AMSP, AAPR, AMRP, ASSP, AMAP, and AFMP were applied into the soil, the concentrations of Ni in the underground part of corn

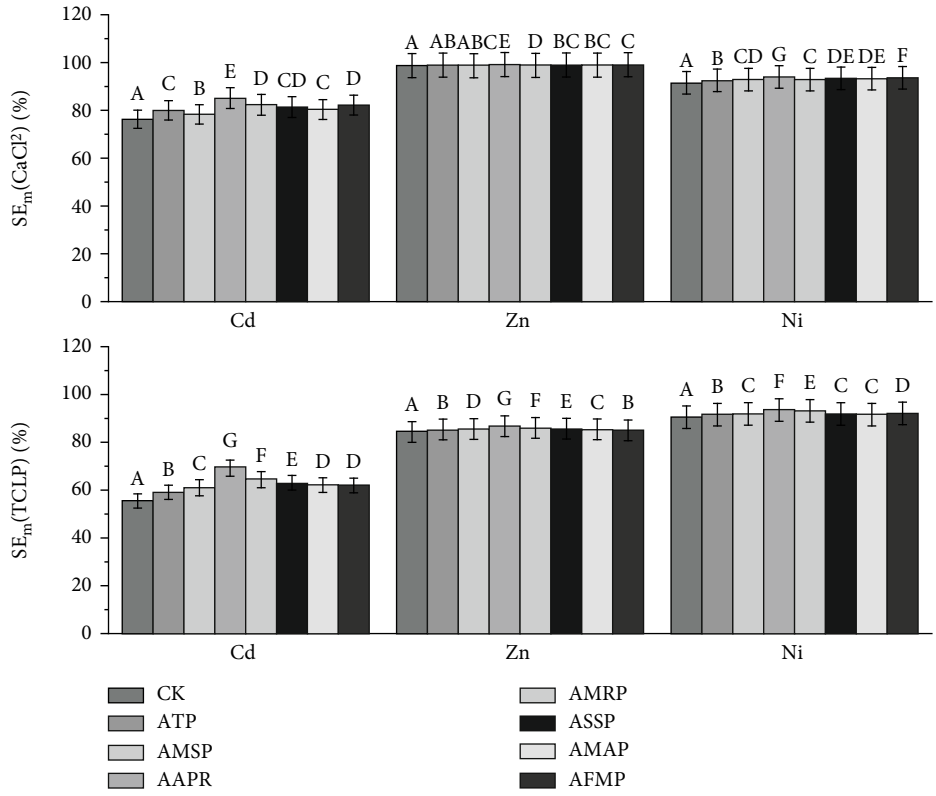

Figure 2: The stabilization efficiency (SE) of heavy metals in stabilized soils. Data were means ± SD ($n = 3$). Column with the same letter has no significant differences between treatment at $P < 0.05$ according to the least significant difference (LSD) test.

Table 3: The ecological risk index (ERI) and comprehensive risk index (CRI) of heavy metals in stabilized soil.

Metal	Extractant	ATP	AMSP	AAPR	AMRP	ASSP	AMAP	AFMP	F-value
	$CaCl_2$	20.01%	21.68%	14.94%	17.68%	18.62%	19.60%	17.83%	35.708***
Cd	TCLP	40.90%	38.83%	30.79%	35.49%	37.14%	37.96%	38.03%	2443.919***
	CRI_{Cd}	60.91%	60.51%	45.73%	53.17%	55.76%	57.56%	55.86%	189.258***
	$CaCl_2$	1.18%	1.17%	0.86%	0.10%	1.14%	1.14%	1.09%	22.035***
Zn	TCLP	14.90%	14.56%	13.23%	14.10%	14.45%	14.76%	14.90%	22229.821***
	CRI_{Zn}	16.08%	15.73%	14.09%	14.20%	15.59%	15.90%	15.99%	926.085***
	$CaCl_2$	7.59%	7.11%	6.04%	7.16%	6.80%	6.87%	6.40%	89.217***
Ni	TCLP	8.45%	8.17%	6.49%	6.87%	8.17%	8.24%	7.91%	1550.145***
	CRI_{Ni}	16.04%	15.28%	12.53%	14.03%	14.97%	15.11%	14.31%	381.208***
CRI		1939.62%	1922.71%	1461.17%	1693.48%	1778.21%	1833.36%	1777.65%	207.068***

***Statistical significance at 0.01.

decreased by 38.15%, 57.79%, 80.86%, 65.07%, 52.70%, 71.50%, and 58.56%, respectively. The concentrations of Ni in the aboveground part of corn decreased by 33.78%, 64.75%, 93.37%, 64.82%, 52.90%, 76.93%, and 59.08%, respectively. The biological concentration factor and the translocation factor of Ni in CK treatments were 0.39 and 0.49, respectively. In the ATP treatments, AMSP treatments, AAPR treatments, AMRP treatments, ASSP treatments, AMAP treatments, and AFMP treatments, the biological concentration factor of Ni decreased by 0.15, 0.23, 0.32, 0.25, 0.21, 0.28, and 0.23, respectively. In the AMSP treatments, AAPR treatments, AMAP treatments, and AFMP treatments, the translocation factor of Ni decreased by 0.08, 0.32, 0.10, and 0.01, respectively. The translocation factor of Ni increased 0.03 in the ATP treatments. In the AMRP treatments and ASSP treatments, the translocation factor of Ni did not change compared with CK treatments.

The whole biological uptaking factor of corn under 8 different treatments was calculated as shown in Figure 4. In the untreated soil, the BUF-Cd, BUF-Zn, and BUF-Ni were the

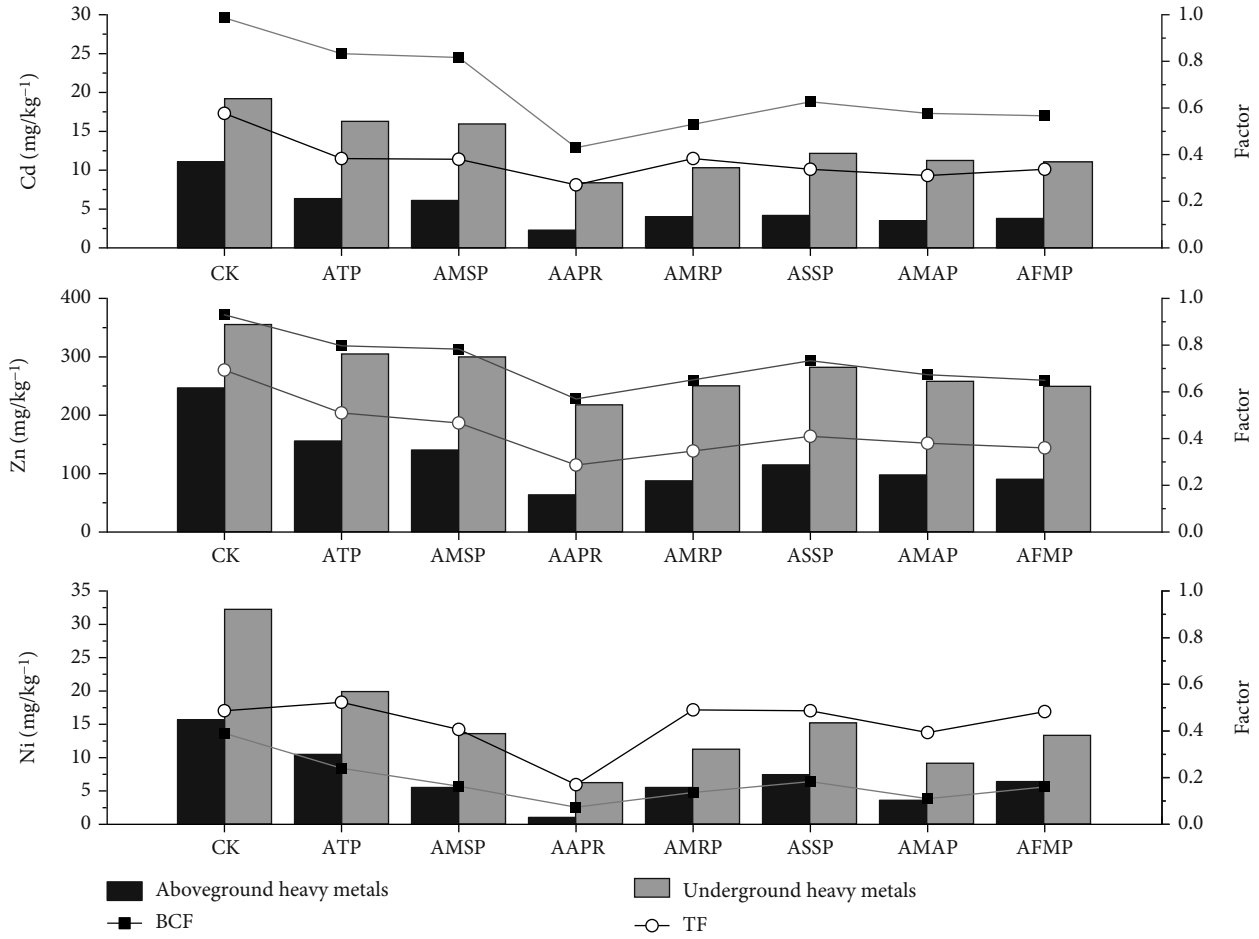

Figure 3: Distribution of Cd, Zn, and Ni in corn under different treatments. Data were means ± SD ($n = 3$). Column with the same letter has no significant differences between treatment at $P < 0.05$ according to the least significant difference (LSD) test.

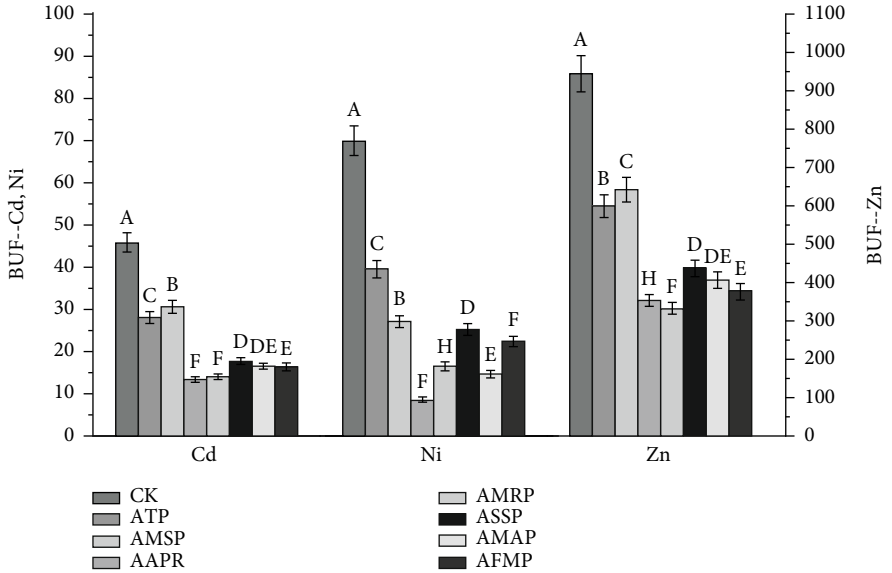

Figure 4: The biological uptaking factor (BUF) of heavy metals in stabilized soils. Data were means ± SD ($n = 3$). Column with the same letter has no significant differences between treatment at $P < 0.05$ according to the least significant difference (LSD) test.

Table 4: The correlation coefficients between accumulation of maize, BCF, and TF, with bioavailability, SE_m, and ERI_m of Cd, Zn, and Ni in soil treated by seven stabilizers.

Metal		$CaCl_2$	TCLP	SE_m-$CaCl_2$	SE_m-TCLP	ERI_m-$CaCl_2$	ERI_m-TCLP
Cd	Aboveground	0.861**	0.878**	-0.862**	-0.878**	0.862**	0.878**
	Underground	0.892**	0.904**	-0.891**	-0.905**	0.891**	0.905**
	BCF	0.890**	0.904**	-0.890**	-0.904**	0.890**	0.904**
	TF	0.914**	0.921**	-0.914**	-0.921**	0.914**	0.921**
Zn	Aboveground	0.765**	0.804**	-0.758**	-0.804**	0.758**	0.804**
	Underground	0.844**	0.819**	-0.839**	-0.819**	0.839**	0.819**
	BCF	0.839**	0.816**	-0.834**	-0.816**	0.834**	0.816**
	TF	0.781**	0.825**	-0.774**	-0.825**	0.774**	0.825**
Ni	Aboveground	0.890**	0.825**	-0.890**	-0.825**	0.890**	0.825**
	Underground	0.897**	0.831**	-0.897**	-0.831**	0.897**	0.831**
	BCF	0.896**	0.828**	-0.896**	-0.828**	0.896**	0.828**
	TF	0.563**	0.592**	-0.563**	-0.592**	0.563**	0.592**

*At 0.05 level, **at 0.01 level, and ***at 0.001 level for significant correlation. $n = 24$.

highest, reaching 45.72, 944.48, and 69.85, respectively. In AAPR treatments, the BUF-Cd and BUF-Ni were the lowest, which decreased to 13.23 and 8.42, respectively. With the addition of passivation materials, the BUF-Cd, BUF-Zn, and BUF-Ni decreased in varying degrees compared with untreated soils, and the reduction ranges were 33.04% to 71.07%, 32.01% to 64.85%, and 43.29% to 87.94%, respectively. Among them, in the AAPR treatments, the BUF-Cd and BUF-Ni decreased by 71.07% and 87.94%, respectively, compared with the CK treatments, and decreased by 52.88% and 78.73% compared with the ATP treatments, respectively. In AMRP treatments, the BUF-Zn was the highest, which decreased by 64.85% and 44.64%, respectively, compared with CK treatments and ATP treatments. According to the significance analysis, AAPR treatments and AMRP treatments are significantly different from other treatments. ($P < 0.05$).

3.5. Correlation Analysis. The correlation analysis of the bioavailability of Cd, Zn, and Ni in soils, accumulation, and translocation of Cd, Zn, and Ni; the stabilization efficiency (SEm) of Cd, Zn, and Ni in soil; and the ecological risk index (ERIm) of Cd, Zn, and Ni in soil are shown in Table 4. The concentrations of $CaCl_2$-extractable Cd, Zn, and Ni and the concentrations of TCLP-extractable Cd, Zn, and Ni were positively correlated with accumulation of Cd, Zn, and Ni in corn, BCF, TF, ERIm-$CaCl_2$, ERIm-TCLP. SEm-$CaCl_2$ and SEm-TCLP were negatively correlated with the concentrations of $CaCl_2$-extractable Cd, Zn, and Ni and the concentrations of TCLP-extractable Cd, Zn, and Ni and the accumulation of Cd, Zn, and Ni in mazie and BCF and TF and ERIm-$CaCl_2$ and ERIm-TCLP.

4. Discussion

The result shows that the contents of soil physical and chemical properties such as pH, EC, and CEC will change after the application of modifiers, which will affect the forms of heavy metals and further affect their bioavailability [15, 29]. Soil pH value can affect the existing forms of heavy metals and the progress of various chemical reactions [30]. Generally speaking, there is a negative correlation between soil EC and CEC and the bioavailability of heavy metals in soil. The higher the soil EC and CEC values, the easier it is for heavy metals to be absorbed, thus reducing the migration capacity [31]. The result also shows that attapulgite modified by phosphate as passivation material has a great influence on the physical and chemical properties of soil. Compared with the addition of attapulgite alone, the soil pH, soil EC, and soil CEC of attapulgite modified by all kinds of phosphate are significantly different from those of CK treatments. Among them, the soil pH, soil EC, and soil CEC values of AAPR treatments were the highest among the 8 treatments, which increased by 2.47%, 5.72%, and 66.31% compared with CK treatments, respectively. The soil pH, soil EC, and soil CEC of AAPR treatments increased by 1.42%, 13.62%, and 53% compared with ATP treatments, respectively. The result also shows that attapulgite modified by oxalic acid-activated phosphate powder can significantly improve the physical and chemical properties of soil, for the reason that phosphate rock powder is a kind of semialkaline substance; at the same time, Ca^{2+} and Mg^{2+} are dissolved in phosphate rock powder after oxalic acid activation, thus improving soil pH and soil CEC. This is consistent with the research results of Huang et al. [32, 33]. In addition, the modification of attapulgite with sodium dihydrogen phosphate, potassium dihydrogen phosphate, ammonium dihydrogen phosphate, and fused calcium-magnesium phosphate can also improve the soil CEC, by 36.95%, 7.61%, 25.69%, and 30.52%, respectively, compared with ATP treatments, thus achieving a better effect of passivating heavy metals. However, after the attapulgite is modified with sodium dihydrogen phosphate, potassium dihydrogen phosphate, calcium superphosphate, ammonium dihydrogen phosphate, and fused calcium-magnesium phosphate, the soil pH value decreases, which

is related to the physical and chemical properties of sodium dihydrogen phosphate, potassium dihydrogen phosphate, calcium superphosphate, ammonium dihydrogen phosphate, and fused calcium-magnesium phosphate. The pH values of these phosphates are all less than 5.0. After the attapulgite is modified with these five phosphates, the soil pH value decreases somewhat, but the decrease is not significant, and after the addition of attapulgite, the pH value of these phosphates is less than 5.0. After the addition of attapulgite modified by phosphate, the soil pH value decreases slightly. The pH of soil is above 6. 0. Attapulgite modified with sodium dihydrogen phosphate, oxalic acid activated phosphate rock powder, potassium dihydrogen phosphate, calcium superphosphate, ammonium dihydrogen phosphate, and fused calcium-magnesium phosphate significantly increased the content of available phosphorus in soil, because these phosphates themselves are water-soluble phosphates, and the available phosphorus content of phosphate rock powder significantly increase after oxalic acid activation, so that the content of available phosphorus in soil will significantly increase [34].

The result shows that the interior of attapulgite single crystal is honeycomb inner channel, the single crystal fiber exists in the form of parallel arrangement, and there are many voids between the single crystal fiber, which is rich in metal cations such as Si, Al, and Mg, which can adsorb and exchange with heavy metal ions in soil, thus reducing the bioavailability of heavy metals in soil [35]. On the other hand, phosphate can react with heavy metals such as coprecipitation and chelation, so that more heavy metals in soil can be transformed into residual state, which has a good passivation effect [36]. The result shows that after attapulgite supports oxalic acid activated phosphate rock powder, potassium dihydrogen phosphate, calcium superphosphate, ammonium dihydrogen phosphate, and fused calcium-magnesium phosphate, the concentrations of $CaCl_2$-extractable Cd in the soil decreased by 25.38%, 11.79%, 6.92%, 2.05%, and 11.03% compared with ATP treatments, respectively. The concentrations of $CaCl_2$-extractable Zn in the AAPR treatments, AMRP treatments, ASSP treatments, AMAP treatments, and AFMP treatments decreased by 26.99%, 15.49%, 3.32%, 3.54%, and 7.30% compared with ATP treatments, respectively. This is consistent with the research results of Wang et al. [15], Zhang et al. [13], Zhao-bing et al. [37], and others. It shows that the loading of phosphate can effectively increase the coordination exchange and chelating ability of attapulgite, enrich the reaction mechanism between attapulgite and heavy metals, and improve the passivation effect.

By adding AMSP, AAPR, AMRP, ASSP, AMAP, and AFMP, the stabilization efficiency of heavy metals in soil was effectively improved and the ecological risk index of soil was reduced. This is mainly because the passivation materials effectively reduce the content of available heavy metals in the soil and then reduce the ecological risk index of the soil [38]. After attapulgite was modified by phosphate, through the enhancement of complexation and precipitation with heavy metal ions such as Cd, Zn, and Ni, stable phosphate precipitation was formed [39], which reduced the enrichment and transport ability of Cd, Zn, and Ni in corn, thus reducing the ecological toxicity of soil [40].

5. Conclusion

The present study indicated that phosphate-modified attapulgite can effectively change the physical and chemical properties of soil, improve the stability of heavy metals in soil, and reduce the migration of heavy metals. Compared with the single application of attapulgite, the modification of attapulgite with oxalic acid-activated phosphate rock powder reduced concentrations of $CaCl_2$-extractable Cd and Zn and Ni by 25.38%, 26.99%, and 20.32%, respectively, and TCLP-extractable Zn and Ni decreased by 24.72%, 11.18%, and 23.20%, respectively, which effectively improved the remediation efficiency of soil heavy metals and reduced the ecological risk index of soil environment. In order to achieve the purpose of stabilizing heavy metals. In addition, AAPR can also increase soil pH and CEC, increase the content of available P, available K, and available N, reduce the content of Cd, Zn and Ni in the aboveground part of corn, reduce the accumulation of Cd, Zn, and Ni in the underground part, and transfer to the aboveground part, thus effectively reducing the ecological toxicity of heavy metals.

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

All authors disclosed no relevant relationships.

Acknowledgments

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Retraction

Retracted: Development and Utilization of English Online Course Resources Based on Fuzzy Neural Network

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] D. Liao, "Development and Utilization of English Online Course Resources Based on Fuzzy Neural Network," *Journal of Sensors*, vol. 2022, Article ID 1795446, 11 pages, 2022.

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Research Article

Development and Utilization of English Online Course Resources Based on Fuzzy Neural Network

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Since the reform and development, after decades of changes in the times, China's basic education reform has been promoted several times, and the degree of information technology in the campus will become one of the important factors for parents to choose this school or not. From digital projectors since 2003 to multimedia-assisted English teaching nowadays, it is evident that online English teaching has become an important part of today's English online resources, but most of the English online resources nowadays are developed by professional research institutions, which leads to a situation where online English curriculum resources are not closely connected to the actual English teaching mode, and more importantly, there is a lack of online English course resources and they are outdated. In the new curriculum reform requirements, the development and utilization of English online resources are clearly pointed out, which shows the importance of developing and utilizing English online course resources and the need to develop in the direction of innovation and modernity, and the need to consider combining the development and utilization of English online course resources with modern technological progress, not only at the theoretical level but also at the practical level. English is a comprehensive and practical language that needs to be used and reinforced by users in order for them to be able to communicate and express their thoughts in English. In this paper, we adopt a fuzzy neural network approach and a gradient descent algorithm to address the shortcomings of current English online course resource development and utilization, and adopt an averaging process for weight updates, and then realize the control of the number of fuzzy rules by adding pooling operations. The experimental results show that this paper can effectively develop English online resources.

1. Introduction

With the rapid change of technology and the continuous development and progress of education, the subject teaching of English has become more and more important, for reasons undoubtedly linked to the general context of economic globalization [1].

However, with the recurrence of the epidemic, people have to implement the new teaching mode of online teaching on a large scale in order to prevent and control the new coronavirus. Such teaching mode makes the communicator across the cold screen not notice or blindly judge the expressions or some subtle body movements expressed by the other party without considering the cultural background and then may misunderstand the meaning expressed by the other party [2]. Is the reason for these problems only because of online education or online communication? The answer is no, because ultimately, there is a bias in educational resources, and teachers do not develop and use them well enough to teach students the relevant content. For example, in our country, the nod of the head is a sign of agreement [3], and teachers usually tell students directly that if they say "agree," it means "agree" in our country. However, if students go to India or Arabia, they will find that nodding means "disagree." The root cause of this cognitive bias is that teachers have not explored the essence of English curriculum resources and have not taken into account the fact that the same body movement or even the same word can have very different meanings in different country contexts. Therefore, with the repeated outbreaks of the

epidemic, online teaching methods have become a routine for most students, and the development and utilization of online curriculum resources for English are imminent [4].

Nowadays, the role of English online course resources in teaching has become more and more important [5]. In addition, a search for the keywords "development and utilization of English online course resources" on the Internet resulted in only one paper, which analyzed the development and utilization of English online course resources in junior high school from a theoretical perspective, but the authors did not apply them to the actual teaching process. The authors did not apply them to actual teaching sessions or only proposed some strategies [6]. However, these strategies have some reference significance for this paper.

In order to develop and utilize English online course resources more fully, this paper will discuss and analyze from the perspective of algorithm theory and then design a fuzzy neural network model that can reasonably develop and utilize English online resources and provide some reference significance for the subsequent development and utilization of English online resources using fuzzy neural networks [7].

2. Research Background

Since the reform and development, after decades of changing times, China's basic education reform has been promoted several times, and the degree of informatization in the campus will become one of the important factors for parents to choose this school or not [8]. The reason for this is that the level of informatization in a school is linked to whether the resources in the campus are reasonably developed as well as utilized. And it is on the premise of the rapidly changing technology and data-based background that whether teachers have rich English online course resources and whether they have appropriate multimedia to assist the development of English online teaching activities become an important software factor that restricts the modernization of English education [8].

However, as of now, most of the English online course resources in China are developed by professional organizations [9], which leads to a disconnect between the practical application and the connection of the development of the resources actually. With the advent of the data era, China has also begun to pay attention to data mining of massive amounts of data and to summarize and utilize the mined data in a reasonable way, which can also be considered as a basic step in the development of English course resources by professional institutions. However, such a development approach can have some problems, as described below [10].

(1) The disconnect between the research and development team related to English online course resources and the actual teachers and students [11]

With the development of technology, the thinking of the research and development team may have the problem that the developed resources cannot keep up with the trend of the times because of the lack of integration with the reality and the solidification of thinking, which in turn leads to the development of English online course resources that are also disconnected from the teaching and learning process of teachers and students. The new era of English curriculum reform requires that English teaching in the new era should be not only basic but also open, flexible, and with certain ideas. As far as teaching materials are concerned, the importance of teaching materials as an important teaching resource for students and teachers is self-evident. The problems of the elementary school mathematics textbook of the Humanities Education Edition show that the textbook should be fully equipped with ideological elements in the first place, but the team of the research and development institution is often disconnected from the real teaching process, which in turn leads to a disconnection between ideology and actual education, and this educational philosophy is obviously not in line with modern times. Therefore, as the era of technology as the cornerstone and great intelligence, it is essential to link the development and use of English online course resources with the development of today's technology [12].

(2) Fragmented English online course resources

The recurrence of the epidemic has led many students to learn only through online teaching and learning, and the Internet has provided an extremely broad arena for the richness of English curriculum resources at all grade levels, but some teachers' ability to integrate and filter English online resources still needs to be improved, which in turn has led to the disadvantages of disorganization, fragmentation, and fragmentation of today's English online resources. Likewise, because of the disorganized English teaching resources on the Internet, teachers spend a lot of effort to collect various teaching resources and teaching materials, but the online English curriculum resource base is superficially rich in content, but in reality, it is superficial. A more serious problem is that the current English online resources are not serialized enough, and the logical framework of the online curriculum resources is ambiguous, lacking in innovation and personalization, which in turn makes it difficult to provide teachers and students with more effective independent learning resources [13].

(3) Underutilization of course resources

As mentioned above, English online resources on the Internet today are actually quite colorful, but a big problem is that they are only "diverse" and do not form a "series" [14], i.e., the wide range of English online. The lack of categorization of online teaching resources on the Internet makes it impossible for teachers to find what they want when they use them to design corresponding teaching contents. Teachers are exhausted after spending a lot of manpower and resources on collecting teaching resources, so a phenomenon has emerged that many university teachers copy the PPT or other teaching resources from the Internet. This kind of teaching design not only is unhelpful to students' learning but also highlights the shortcomings of insufficient utilization of English course resources and the

difficulty for both teachers and students to find effective independent learning resources on relevant resource platforms.

3. Materials and Methods

3.1. Overview of Data Mining. Data mining, called DATA Mining, abbreviated as DM, represents the process of extracting knowledge and information with value factors, or with certain laws and unknowns, from a large amount of unordered, incomplete, fuzzy, and random data containing noise and other disturbing signals [15]. The emergence of data mining technology is the inevitable choice of history, because today, a large number of decision analysis requires the support of data analysis and the objectivity of data mining has a significant role in decision analysis. In this paper, firstly, data mining provides technical support for the development and utilization of English online course resources, and secondly, the vast amount of English online course resources presents a cluttered nature that is ideal for data analysis to uncover valuable and meaningful potential online English resources that teachers and students need, so that users can get the resources they want and reduce the amount of irrelevant content. Appearance is the original purpose and meaning of this paper's implementation.

Data mining is a multidisciplinary aggregation in which data mining techniques include or all include the implementation of database systems, machine learning, statistics, and a variety of algorithms and data visualization. The basic process of data mining can be shown in Figure 1 [16].

As can be seen from Figure 1, the basic process of data mining can be composed of five steps, which include specifying the objectives, data collection or determining the database to be used, data preprocessing, constructing a model, and evaluating the model or predicting the relevant results. Among them, building a model is the core of the whole data mining analysis process, mainly through the data mining algorithm or optimization of the algorithm to obtain the relevant training model, so as to use visual means to output the accuracy or prediction results.

The first is to clarify the goal, as the name implies, to clarify the goal is to carry out data mining people in the implementation of the act of data mining to know clearly what kind of results they want to get, that is, through data mining technology to solve what kind of problems. In this paper, the clear goal is to find the English online course resources with potential value or direct meaning for different users, i.e., to achieve personalized recommendations for different users and then to achieve the effective development and utilization of English online course resources. It is clear from this that the problem to be solved in this paper is how to achieve effective use and development of English online resources.

The next step is data collection. After the previous step, the paper has got a clear objective and the problem that needs to be solved, and the next step is the indispensable step of data collection. Data collection is a very important process, and the result of data collection is likely to have a direct impact on the output, which determines the smoothness of the subsequent work of the thesis. One of the techniques regarding data collection is often implemented using crawler technology, and the results of data collection will be presented in this paper in Section 4, experimental simulation.

The third step is data preprocessing. Data preprocessing can also be understood as data cleaning; in this process, the main "cleaning" is the data outliers, missing values, etc. The purpose of the preprocessing is to ensure that the relevant data must meet the input requirements and "clean." If the data is not preprocessed, it will greatly affect the accuracy of the final output or prediction results. The quality of data preprocessing also affects the accuracy of the final results. The cleanliness of the data preprocessing or data cleaning can usually be influenced by the following aspects.

(1) Outliers: outliers generally refer to observations that are far from normal samples. For example, in the k-neighborhood algorithm, after the initial k-value and the correlation distance threshold are determined, some points will be far beyond the set threshold, and such data sample points are supposed to be eliminated. If these data samples are not rejected, the existence of outliers will directly affect the accuracy of model evaluation

(2) Missing values: missing values are usually generated during the data collection process, usually due to technical aspects or personal privacy factors that prevent certain data samples from being observed or collected, thus resulting in missing data samples. The presence of missing values may lead to errors in model evaluation

(3) Different magnitudes: nowadays, most research data are generally collected in two ways: one is to download relevant datasets directly from the Internet, and the other is to use crawling techniques. The raw data collected by crawling techniques have more or less different outlines before they are processed. Therefore, it is necessary to unify the collected raw data by the method of data standardization to unify the data with dimensional differences, such as the CTC alignment method to unify the speech text information in the research of speech recognition projects, and then get the uniform dimensional language text input

(4) Complexity of dimensionality: for large-sample datasets, the collected data often contain thousands of data vectors, and if the neural network is used to train the data samples directly, the high-dimensional data vectors will cause the model training to be slow or even nonconvergent, which not only affects the model running efficiency but also greatly increases the complexity of the model. This not only affects the efficiency of the model but also greatly increases the complexity of the model. For example, in convolutional neural networks, researchers put the high-dimensional feature vectors obtained from the convolutional layer into the pooling layer for dimensionality reduction and then use the softmax layer to output the model training results or test results

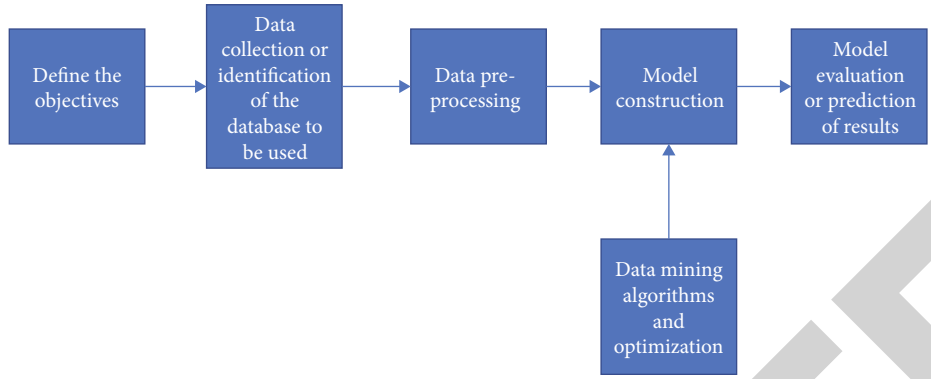

Figure 1: The basic process of data mining.

The fourth step is to build the model. Building the model is the most important and core part of the whole data mining. Before building the model, the first thing you need to consider as a researcher is what kind of model to use for building. In data mining model, modeling generally has traditional machine learning algorithms and neural network-based methods for modeling. Among the traditional machine learning algorithm-based modeling approaches are generally classification models and regression models, with classification models generally referring to logistic regression, *k*-nearest neighbor classification algorithms, decision trees, etc. and regression models generally referring to linear regression, ridge regression (essentially a modified least squares method), and support vector regression [17].

Meanwhile, the "dimensional complexity" mentioned above requires the establishment of corresponding feature engineering in classical machine learning algorithms, which is generally complex [18] and requires a lot of resources to build, but deep learning does not need to establish such an engineering but only needs to pass the processed input data. It is only necessary to pass the processed input data directly to the neural network, and then, the processed feature vector can be downscaled using operations such as pooling to output the obtained results using fully connected layers [19].

In summary, the research goal of this paper is to develop and utilize the massive, disordered, fuzzy, and random online English course resources, and data mining techniques can achieve this goal. The basic process of data mining can be divided into five steps, of which building a model and selecting a model are the most important part, and the selection and optimization of the algorithm in building the model occupy more than 80% of the whole data mining work. The final choice is to use deep learning algorithms to build a training model for English online course resources and fuzzify the resources by creating affiliation rules and other steps to achieve personalized recommendations for users and finally achieve the development and utilization of English online course resources.

3.2. Data Mining and Neural Network Relationship Identification. In the previous section, we discussed the development and utilization of English online resources using data mining technology and sorted out the 5 major steps of data mining technology, so as to obtain the model construction scheme that will realize the effective utilization and development of English online course resources based on fuzzy neural network. The theoretical basis is provided.

From the definition of data mining, it can be said that data mining is a classification problem, and neural network can be considered as a form of data mining implementation. Neural network (NN) is known as artificial neural network, abbreviated as ANN in English, and the methodological view is that it is a mathematical computation and operation model that mimics the functions and results of biological neural network. And the modern neural network model or system is a nonlinear statistical tool for modeling datasets and is widely used for modeling complex input and output relationships, or essentially, an ANN is a model used to explore data [20].

In this paper, the huge amount of English online course resources is itself a very large dataset or sample set, which is stored in various places on the web, and in order to get the relevant dataset will be crawled and centralized using crawler techniques on the web. However, the goal of this paper is not to get these data, but to process and train these data and finally to mine the data that has potential value to students or teachers, and this process of "processing and training the data" is the basic process of data mining. "Training" can be considered as the process of invoking neural network algorithms, which is included in the data mining process, and the final output will be visualized through the training method of neural network model to output the corresponding accuracy and model prediction results, etc. These visualization results are the criteria for measuring the quality of the whole data mining process.

3.3. Fuzzy Neural Network. Since English online course resources are disordered and fuzzy, they need to be logically inferred through certain affiliation rules before they can be applied to the neural network and trained by the neural network model. This logical inference process can be understood as interest metrics in this paper and then the process of personalized recommendation for different users. In contrast, fuzzy neural networks are based on artificial neural networks and fuzzy control theory as the core. At first, they were only applied to the problem of poor accuracy in expert

systems and were finally formed by establishing fuzzy rules to achieve logical reasoning between fuzzy conclusions and conditional attributes and combining them with the adaptive learning approach of artificial neural networks. As the research progresses, fuzzy neural networks have gradually started to develop into the field of data mining from the initial problem of poor accuracy of expert systems.

Before describing fuzzy neural networks, it is important to understand fuzzy theory. Fuzzy theory is first of all "fuzzy," "fuzzy" refers to a certain degree of cognitive fuzziness of a concept or definition, and to reason by fuzzy inference requires fuzzy sets. Fuzzy theory was proposed by American scholar L.A. Zadeh in 1965. Its theoretical meaning is that there is a fuzzy set, which is the actual data situation, and then, it is artificially divided into different sets, and then, the expression of the affiliation function is determined according to the research experience of experts, and finally, the affiliation function is used to calculate the affiliation degree of each data set, so as to achieve the purpose of classifying the data. Finally, the data with high similarity are grouped into one set according to the affiliation degree.

The more important concepts in fuzzy theory are affiliation function and degree of affiliation and fuzzy operations. Figure 2 shows the five steps of fuzzy inference.

Next, in the whole process of fuzzy reasoning, the first thing to understand is what is the basic idea of fuzzy control? Why fuzzy control theory is combined with neural networks in this paper and why it is decided to use fuzzy neural network model for English online course resource development and utilization?

In fuzzy control, the most important and core idea is to achieve human experience control through the use of computers, which can be understood as a higher level of mathematical operations; artificial neural networks are essentially a mathematical model applied to bionic research, which is mainly applied to the structure of neural prominence connections similar to the human brain to process information. For English online course resources, the presentation of many of them is fuzzy, uncertain, and difficult to measure with mathematical accuracy, but the personalized recommendation of the resource to the users or the demanders requires a certain degree of accuracy. At the same time, for the generalization of the content of the English online course resources and the accuracy of the recommended content, we can consider the expert experience to make artificial rules for the data source to interfere with the personalized recommendation results, and the fuzzy dataset can eventually be trained through the artificial neural network model to produce a more satisfactory result; of course, the accuracy of this result is inseparable from the design of the whole fuzzy neural network model. In order to better design this model, the next part of this paper will describe the basic types of fuzzy neural networks.

The basic types of fuzzy neural networks can be broadly classified into five types, which are distinguished by the combination of the two.

The first is the network type. "Network" means neural network, which means the introduction of neural network into the fuzzy inference system, and then, the learning and control of fuzzy rules are realized by neural network, and finally, the model has the ability of adaptive learning.

The next is the tandem type. This model ensures that the advantages of both algorithms can be exploited simultaneously.

The third type is the parallel type. This model has a high accuracy rate in data processing.

The fourth type is the nondirectly connected type. This model indicates that each independent part is responsible for its own work, and the two parts are not substantially related. This model does not essentially integrate fuzzy control with neural networks, which ultimately leads to results that are more biased and less accurate.

The fifth type is the equivalence type. The equivalence type indicates that all neurons are equivalent to fuzzy neurons and all neuron nodes possess fuzziness, and this model is more widely used in the field of fault detection.

4. Results and Discussion

4.1. Process Analysis of Algorithm Implementation. Through the discussion in the above sections, it can be obtained that a fuzzy neural network is essentially a combination of a fuzzy inference system and a neural network, of which there are now five ways of combining the two in the study. In this paper, in order to better develop and utilize English online resources effectively, as well as to improve the accuracy of personalized recommendations to users and increase the user's experience when using the English online course resource system, the basic model used is network-based; i.e., a neural network is incorporated into the fuzzy inference system, and the determination and control of fuzzy rules is achieved by using the adaptive learning ability of the neural network. In this process, the important features of the fuzzy inference system are retained while highlighting the powerful algorithmic capabilities of neural networks in data mining processing. The fuzzy neural network model is used to learn and train the obtained dataset while the corresponding affiliation function is determined and error adjusted using the relevant algorithms of neural networks. This network type of fuzzy neural network not only enables the overall network to have learning and adaptive capabilities but also ensures the learning efficiency and accuracy of the final output results of the neural network system while playing the inference advantages of the fuzzy inference system.

Among them, the basic network structure of the fuzzy neural network model system used in this research corresponds to the fuzzy inference system as follows, as shown in Figure 3.

In Figure 3, the first layer is the input layer, which corresponds to the one-to-one correspondence of the exact values of the samples. The third layer can also be called the "with" layer; the number of nodes in this layer is the number of fuzzy rules, such as the second layer of $\times 1$ m nodes and $\times 2$ n nodes of each node to take a node only with each node of the layer, together with the composition of $m * n$. This layer is mainly used to develop rules in the fuzzy neural network model; the fourth layer can also be called the "or layer," in which the fuzziness of the output variable is divided,

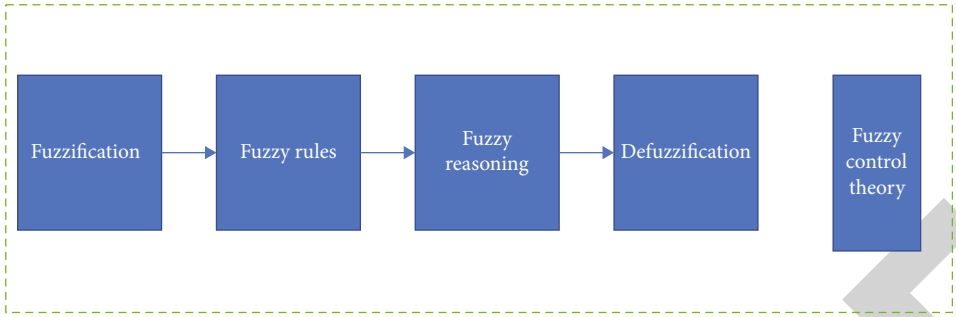

Figure 2: The basic process of fuzzy inference.

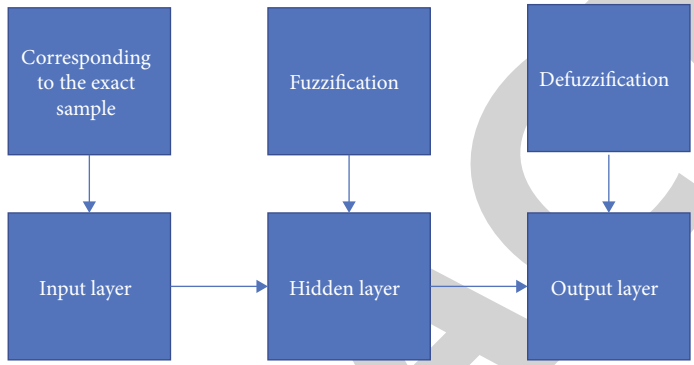

Figure 3: Correspondence between the basic network structure of the fuzzy neural network and the fuzzy inference system.

where the number of nodes in the layer is the number of output variable fuzziness q. The fifth layer is the defuzzification layer, in which the number of nodes indicates the number of output variables, and the physical meaning is to convert the fuzzified values to the exact values of the output variables. It is important to note that the third, fourth, and fifth layers are fully interconnected in the form of the affiliation function parameters in layer 2 and the weights in layers 3, 4, and 4 and 5 are adjusted with the training model.

The fundamental difference between neural networks and fuzzy neural networks is that each layer of fuzzy neural networks has a certain physical meaning and is a combination of logical reasoning, expert experience and knowledge, linguistic computation, and linear dynamics with the ability to learn, reason, identify, associate, adapt, etc. More importantly, the key to the fuzzy neural network model is the optimization of the weight coefficients. The optimization of weight coefficients is linked to the learning algorithm of the neural network, and the following learning algorithms are available in the fuzzy neural network model, as shown in Table 1.

In this paper, the basic idea of building an English online course resource development and utilization system is to obtain relevant English online resources by using crawler technology, thus forming a dataset of about 1500 items, extracting 1200 items from this dataset as a training set and 300 items as a test set of data samples, and training and calibrating the processed training and test sets by designing a fuzzy neural network model. Therefore, in order to achieve better data mining results and maximize the development and utilization of English online course resources, the corresponding learning objective of this paper is obviously the structured learning approach of Figure 1, and through comprehensive consideration, this paper finally chooses to use the gradient descent algorithm to achieve the training and data mining of the fuzzy neural network model.

In this paper, the algorithm flow for the development and utilization of English online course resources based on fuzzy neural network model is as follows, as shown in Figure 4.

In Figure 4, it can be seen that the key of this model lies in the learning algorithm, and the gradient descent algorithm used in this paper mines the data rules of the dataset to realize the personalized recommendation function for users. Among them, the idea of gradient descent method is mainly related to the differential in mathematics, the gradient is the slope of the function in the meaning of mathematics, and the gradient descent corresponds to the movement of the left and right direction of the established differential derivative.

In the gradient descent algorithm, the formula for updating the weights used in this paper is as follows:

$$w_{i+1} = w_i - \alpha * \frac{dL}{dw_i}. \tag{1}$$

In formula (1), w_i is the starting value of the weights, w_{i+1} is the updated value of the weights, α is the learning rate of the algorithm; in this paper, the α starting value is set equal to 0.001 and then adjusted according to the degree of

Table 1: Several learning algorithms for fuzzy neural systems.

Learning objective	Specific algorithm	Characteristic
Structure learning	Mainly using clustering methods, extraction of rules from sample data	Subtractive clustering, entropy clustering, self-organizing clustering, incremental learning algorithms (LMS), genetic algorithms, and gradient descent methods
Parameter learning	Learning of parameters, which is essentially an optimization process	BP algorithms, genetic algorithms, rough set theory, particle swarm theory, and chaos theory
Hybrid learning	Parameter learning and structure learning are performed dynamically during the learning process	OLS methods based on fuzzy basis functions, augmented learning methods, hybrid algorithms (e.g., a combination of least squares and BP algorithms)

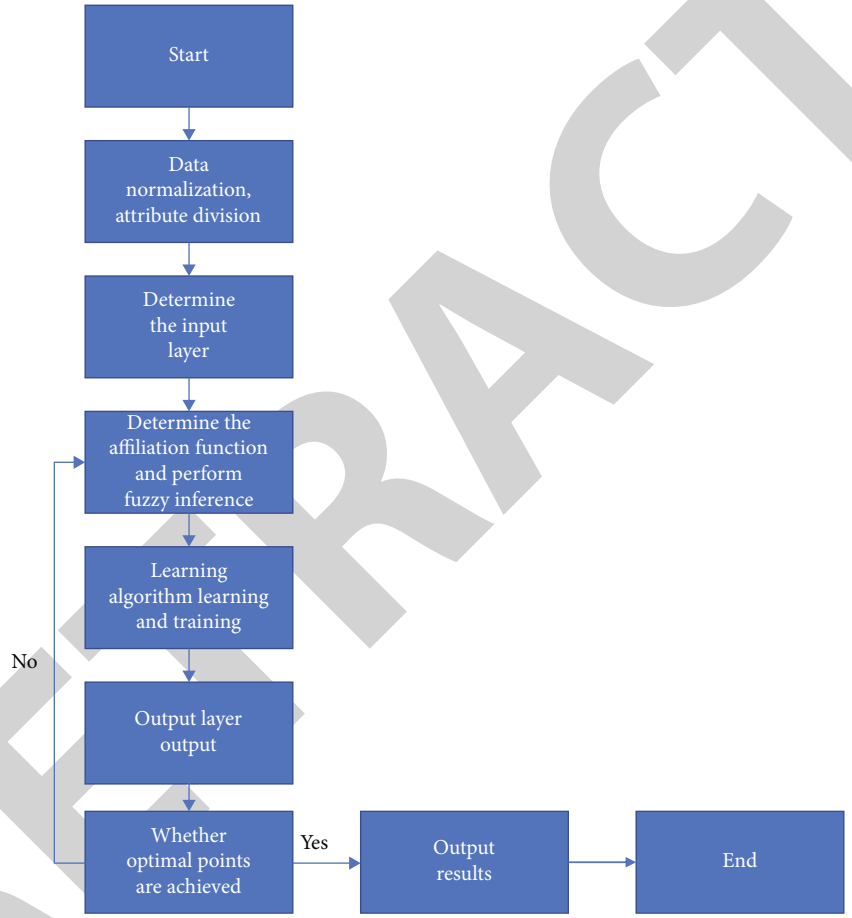

Figure 4: Algorithm flow for the development and utilization of English online course resources based on fuzzy neural network model.

convergence of the output loss curve of the system, so as to achieve the purpose of adjusting the direction of gradient descent and then make the whole model to the direction of the global optimum.

Meanwhile, in order to make the performance of the algorithm optimal, the weights obtained from different data samples are averaged in this paper, and this average value will be used as the direction of the weight gradient of the sample as a whole, so the formula can be shown as follows:

$$\overline{w} = \frac{1}{n}\sum_{i=1}^{n}(w_1 + w_2 + \cdots + w_n), \tag{2}$$

where $\bar{w}$ will correspond to the weights in the next w_i iteration process. In order to make the gradient descent algorithm more nonlinear, the bias function is also indispensable in the gradient update of this paper, and the bias b_i function is calculated as follows:

$$b_{i+1} = b_i - \alpha * \frac{dL}{db_i} \tag{3}$$

In this paper, in order to get the best convergence performance, the learning algorithm will keep repeating the above formula in the iterative process until the loss

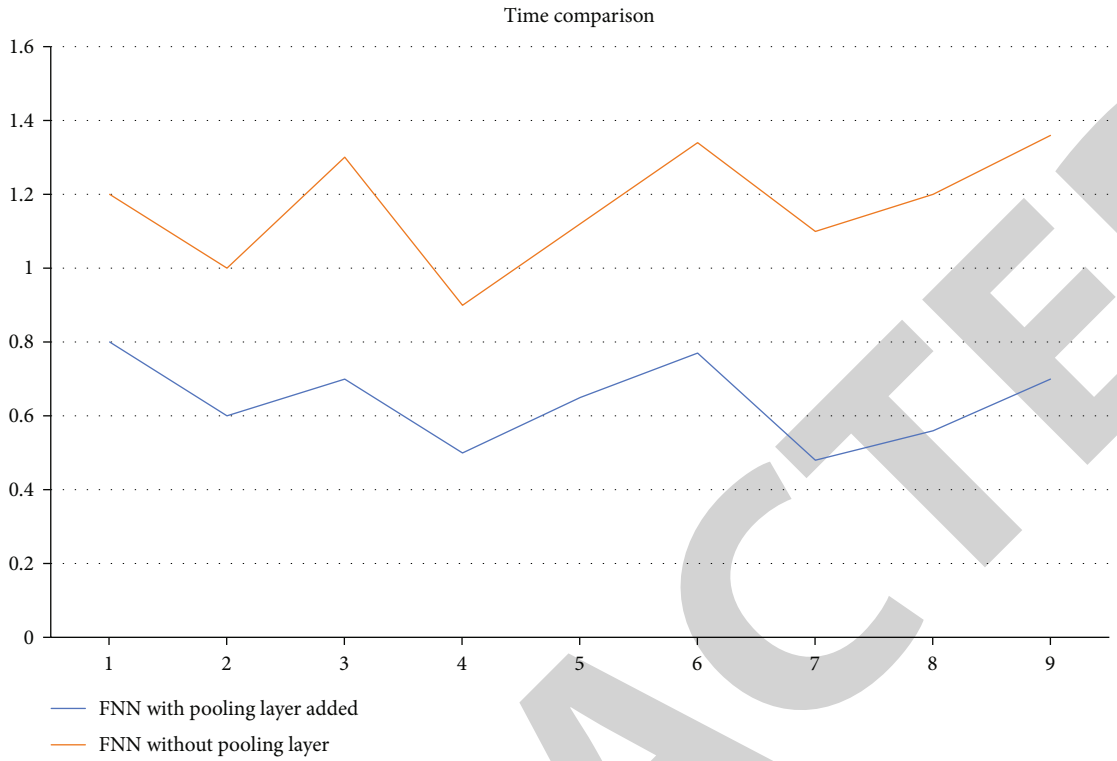

Figure 5: Comparison of FNN with a pooling layer and FNNN without a pooling layer.

function no longer converges or convergence becomes abnormally slow; then, it means that the model has reached the optimal solution.

4.2. Simulation Results and Analysis. To achieve the goal of developing and utilizing English online course resources, this experiment is conducted using the above algorithm with the accuracy of user personalized recommendation as the evaluation index. The results show that as the dimensionality increases, the number of fuzzy rules in the fuzzy neural network model will also grow exponentially therefore, in order to overcome this shortcoming, this experiment will be implemented through the above process when the pooling layer is introduced to achieve control over the number of nodes and reduce the model training time, where the comparison of training efficiency after adding the pooling layer and without the pooling layer is shown in Figure 5.

It can be seen from Figure 5 that the time efficiency of the fuzzy neural system model in this paper is improved by about 10% during the training process by adding or not adding pooling layers to the model.

The fuzzy neural network constructed in this paper is ultimately a 5-layer structure, in which the first and last layers are the input and output layers, respectively; the fourth layer is the newly added pooling layer; the second layer is the fuzzification and affiliation function layer; the third layer is the fuzzy rule formulation layer; and the fourth pooling layer controls the number of fuzzy rules. The final accuracy comparison curves of the two models tested separately in this paper are shown in the following figure.

As can be seen from Figure 6, this paper compares the accuracy curve changes in two cases, one for the fuzzy neural network without the pooling operation and one for the fuzzy neural network with the pooling operation. In Figure 6, the paper uses the English abbreviation FNN for fuzzy neural network to facilitate the discussion. The accuracy of FNN with pooling operation is almost similar to that of FNN without pooling operation, but overall, the accuracy of FNN with pooling operation is higher than that of the network model without pooling operation, and the network is more robust, as shown in Figure 6.

In order to better test the fuzzy neural network model suitable for the development and utilization of English online course resources, this paper decided to use the FNN after adding the pooling layer operation after the curve comparison mentioned above. However, as can be seen from Section 4.1, this paper will take gradient descent algorithm as the learning algorithm of fuzzy neural network after analysis and discussion, and in the gradient algorithm, in order to better control the gradient descent direction of FNN, two comparisons are made in this paper: one is to adopt only the weight update formula and bias function update formula under formulas (1) and (3), named as method 1; the other is to adopt (1), (2), and (3) formulas of the weight update, weight average, and bias function update formulas, named Law 2, and the final error curves through the FNN model are as follows.

From Figure 7, it can be seen that the accuracy of method 1 is lower compared to that of method 2, and method 2 is much better than method 1 in terms of both the robustness of the network and the degree of accuracy,

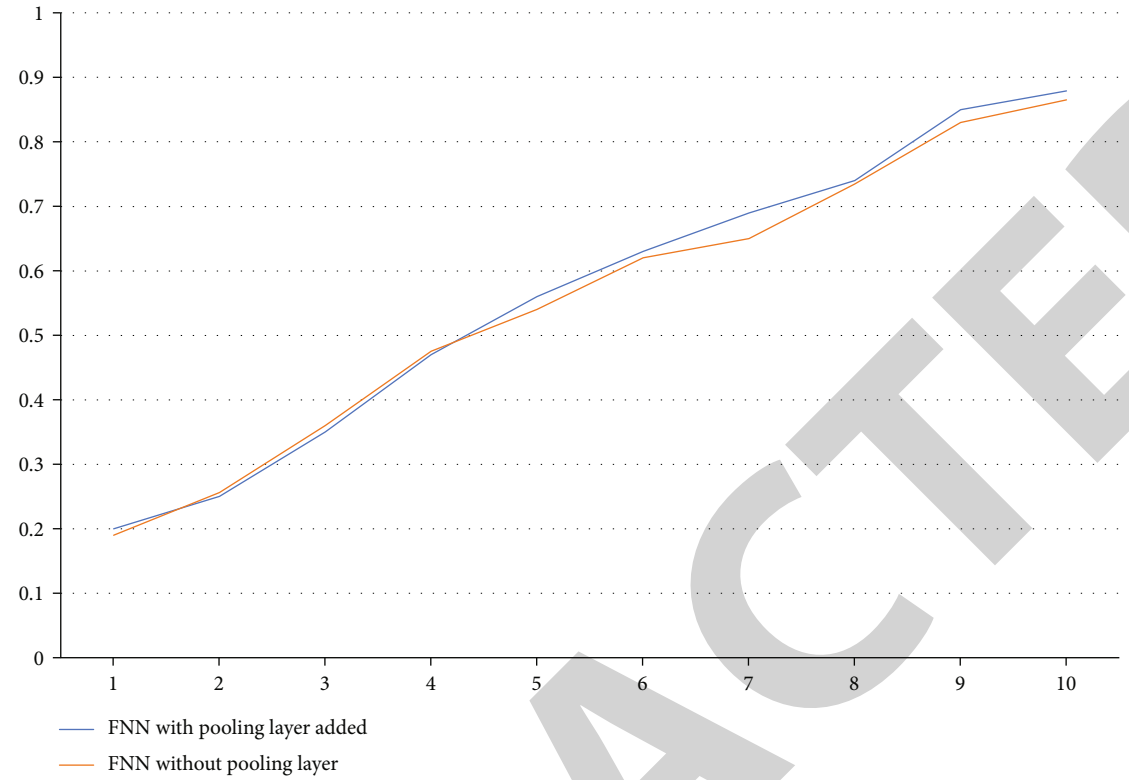

Figure 6: ACC curve of fuzzy neural network training.

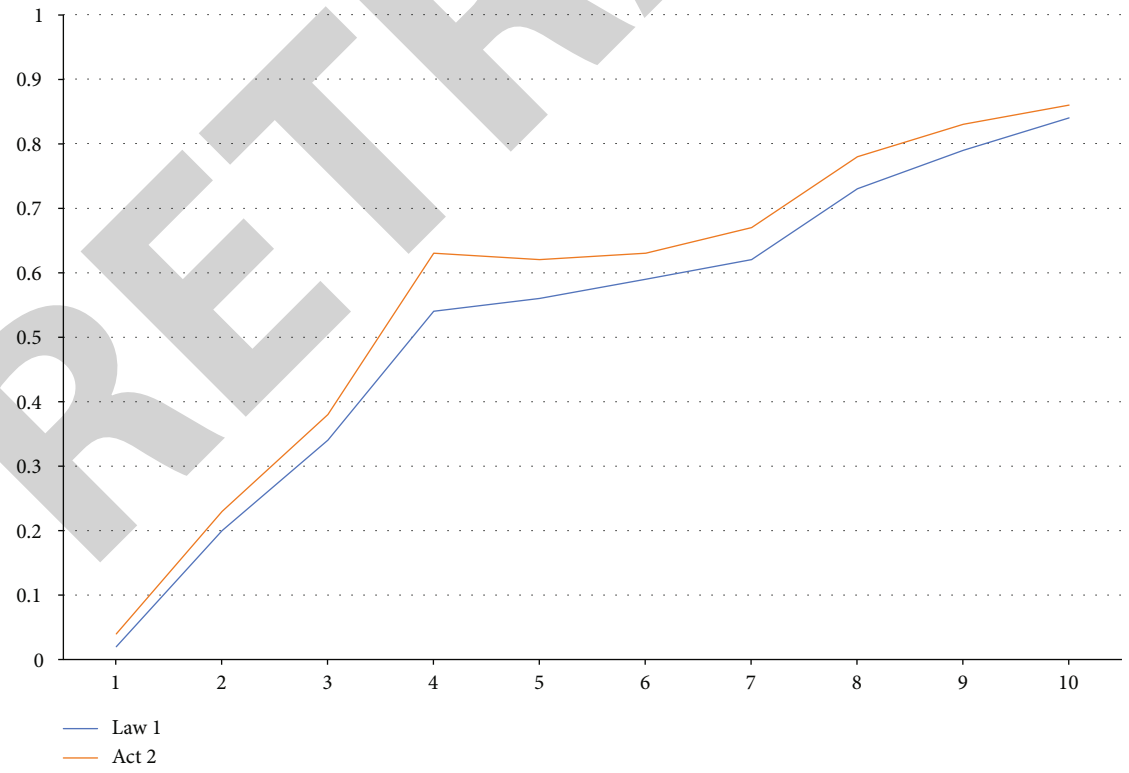

Figure 7: Comparison of accuracy curves under different weight calculation methods.

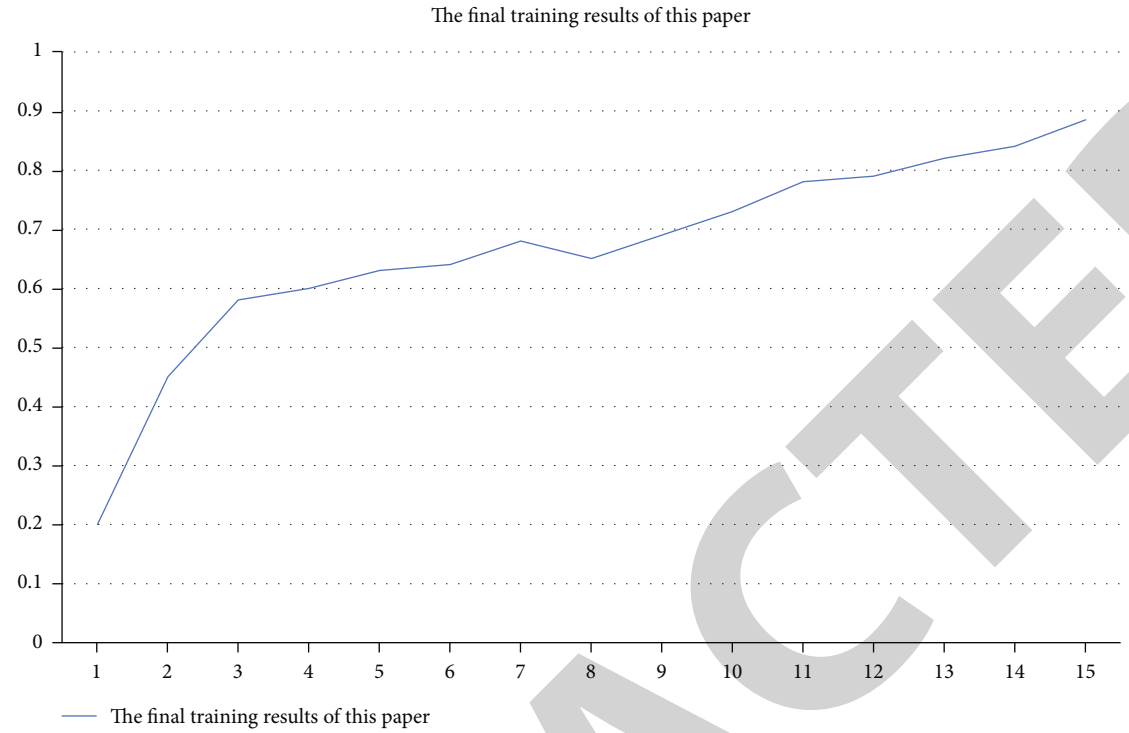

Figure 8: The change of ACC curve of FNN training in this paper after method 2 and adding pooling operation.

so this paper will adopt method 2 and introduce the pooling layer for model training. Figure 8 shows the final training results.

From Figure 8, it can be seen that the accuracy of the model in this paper has been improved to some extent after the operation of the above methods and pooling, by about 3%, and the final measured accuracy is around 89%, which shows that the model is effective when applied to the development and utilization of English online resources.

5. Conclusion

Compared with traditional machine learning algorithms, the neural network-based model uses a deep learning framework and model with higher accuracy and stronger performance, where more importantly, the neural network based on the deep learning framework can be more easily adapted to different domains and applications, and the learning method of migration that makes the pretrained deep network applicable to different applications in the same domain can also play a certain role. This migratory learning characteristic can easily extend its application scope; for example, in the development and utilization model of English online course resources to be studied in this paper, it can be transplanted to different disciplines, such as language and geography, based on the words of the deep learning framework, and the transplantation steps only need to change the corresponding dataset to complete.

This paper proposes to apply fuzzy neural networks to the development and utilization of English online course resources, analyzes them through experiments, and finally makes reasonable modifications to the weight formula and introduces pooling operations, which finally improves the accuracy and robustness of the model training, and experiments prove that the accuracy rate of the development and utilization of English online course resources based on fuzzy neural networks proposed in this paper can reach 89%.

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The author declares no conflicts of interest.

Acknowledgments

This work was supported by Chongqing Education Committee Technology Project under Grant No. Z212053, China National Foreign Languages Guidance Committee of the Ministry of Education under Grant No. WYJZW-2021-105, and Chongqing Education Committee under Grant No.KJQN2020004605.

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Retraction

Retracted: Optimization and Quality Evaluation of Online Teaching Courses Based on Machine Learning

Journal of Sensors

Received 23 January 2024; Accepted 23 January 2024; Published 24 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] S. Li and M. Shi, "Optimization and Quality Evaluation of Online Teaching Courses Based on Machine Learning," *Journal of Sensors*, vol. 2022, Article ID 5081505, 12 pages, 2022.

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Research Article

Optimization and Quality Evaluation of Online Teaching Courses Based on Machine Learning

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Due to the epidemic, online courses have become an important form of school courses, so it is very necessary to optimize online teaching courses. This paper analyzes the survey data by using factor analysis and ANP model and finally determines 18 evaluation indicators by scoring the evaluation indicators by the respondents. The analysis of these 18 indicators shows that the average score of goal setting is the highest, and the average score of interface design is the highest. Lowest: the low-scoring portion of the course interaction is the most important aspect of developing a suggested strategy, and setting the environment, stimulating interest, interface design, and performance evaluation are also important factors in improving the quality of online courses. It can be seen that teacher-student interaction, media presentation, and interest stimulation are three more important factors, and these three factors are relatively less important for performance evaluation, course duration, and language level. It can be seen that learners pay relatively low attention to performance evaluation and pay the highest attention to intelligent learning. These indicators with high attention are improved to optimize online teaching courses.

1. Introduction

The online education quality assessment system is established on the basis of the analytical hierarchy process, the importance of each subsystem and indicator in the online education quality assessment system is determined, and the safety rules of the risk values of each indicator are determined based on up to practical experience. The return model is established by the BP neural networks, and the model weights and thresholds are optimized by the particle swarm algorithm. Based on the online education quality assessment model in the BP neural network, the model parameters are constantly adjusted, the appropriate function is selected, and the particle swarm algorithm used in neural network learning and teaching is optimized. The scientificity of the questionnaire has been verified by means of reliability and validity tests. Based on the score results, combined with the weighting factors of each indicator in the Online Course Quality Indicator System, the main factors influencing the quality of online courses are obtained. Based on the study data, descriptive statistics, analysis of variance, and Pearson's correlation coefficient were used to test the study hypotheses and obtain valuable empirical results. By comparing this model with the standard BP model, the results show that the accuracy of the PSO-BP model is higher than that of the normal BP model, and the PSO-BP model successfully conquers the shortcomings of the BP neural networks [1]. In the era of more and more popular online learning, it is imperative to build an education evaluation system for online courses. In the absence of face-to-face communication and accurate assessment of student skills, online learning ignores process assessments, resulting in one-sided and oversimplified assessments. After analyzing the existing problems and evaluation data, an optimized online evaluation system is proposed for course learning. Based on examples from language and programming courses, it has been demonstrated that the above optimization assessment strategies can help students improve their

learning and make better use of the course [2]. Evaluation of the MOOC bot based on previous Chatterbox Challenge and Loebner Prize competition questions showed that it was able to give correct answers during most of the test period and demonstrated the ability to expand conversations. The advantages of MOOC bots, such as 24/7 service, support for different time zones, multidomain knowledge, and simultaneous sharing of multiple pages, exceed existing limitations [3]. To select effective representations of sentiment, we use the Multiswarm PSO (MSPSO) method, which generates many different swarms of particles in different cross-training subsets. These groups are used to find the best features according to F-Measure Fit. Experimental results on real datasets show that MSPSO can efficaciously decrease the redundancy of version functions and accommodate discriminants. Compared to traditional methods of characteristic selection, MSPSO can achieve better show when choosing the identical dimensions. In addition, the results of the user survey showed that 72.2% of the respondents noted the usefulness of the identification outcome and the utility of job selection [4]. Blackboard teaching is not only a supplement and extension of classroom teaching but also optimizes teaching evaluation from four aspects: learning objectives, teaching shapes and ways, teaching detail, and education. Based on the analysis of the course characteristics and the needs of teachers and students, it is emphasized how to push forward a more complete achievement of the learning objectives and how to deliver a more complete, flexible, humane learning content, open and better prepared. In order to reflect more diverse teaching forms and methods, promote evaluation teaching to be more comprehensive, objective, and efficient, optimize the entire education system, develop blackboard courses, understand material structure, interactive links and evaluation models, and build overall training courses [5]. Autonomous Online Learning Optimization (AOLO) combines Deep Neural Networks (DNNs) with FEM computations. DNN learns and replaces the objective based on design variables. DNN-based optimal prediction dynamically generates a small amount of training data. Adapting to fresh practice data and providing better predictions in convergent areas of interest, DNN is a self-directed online learning method that embeds deep learning into optimization methods to accelerate the learning and optimization process [6]. Based on the exploration of online course evaluation data with big data, an optimization framework has been proposed for evaluating online courses based on process assessment. Using deep learning and collaborative filtering techniques to analyze online course assessment optimization based on online course assessment data and student assessments includes ameliorating teacher teaching and ameliorating student learning efficiency [7]. Through the analysis of the lack of spirit, values, and humanistic spirit of some students, it reflects the current situation of the educational effect of high-quality humanities courses in colleges and universities and tries to discuss it from the perspective of identity. The overall function of high-quality humanities courses, the optimization of the overall organization and design of education, the premise of high-quality courses, the construction of "macro humanities" learning system and quality evaluation system, etc., provide a benchmark for higher education and provide innovation and improvement for learning outcomes [8]. Along with the increase in the quantity of students, the popularization of the net and the development of information management, more and more colleges and universities have implemented online education assessment methods and achieved certain results. However, in application, the management function of the online education evaluation system still needs to be improved and optimized. Based on practical experience, this paper discusses the optimization of online education evaluation system management functions from four aspects: evaluation questionnaire management, evaluation process monitoring, and evaluation result feedback, so as to ensure the effective teaching of student evaluation, help complete student evaluation work, and make management more effective work [9]. In order to enhance the accuracy of teaching quality evaluation in colleges and teaching quality evaluation method, clever optimization algorithm is suggested. Firstly, the rating index system is constructed using the AHP; secondly, the BP neural network is optimized by using a multipopulation genetic algorithm; finally, the BP-optimized neural network is used to assess the quality of education. The experimental consequents display that this means not only overcomes the blindness of neural networks but also ameliorates the accurateness of the nonlinear approximation assessment and that the proposed method is feasible and effective [10]. An important content of physical education is the assessment of the quality of education. The purpose of evaluating classroom teaching is to promote teacher progress and improve the quality of teaching. The article analyzes the optimization of the quality management of physical education based on a neural network. This is conducive to the broad development of students and teachers in the physical education evaluation system in universities. The content of the assessment, indicators, and weights of this indicator have a certain objectivity [11]. With the improvement of education quality, higher requirements have been put forward for the quality of computer education in national universities. High-quality computer education can promote students' mastery of knowledge and increase employment rates. Different colleges and universities have different goals for teacher education, quality, and training, which further undermines the evaluation criteria for the quality of computer education in colleges and universities. The principles of Bloom's method are for categorizing educational goals, establishing and improving computer optimization [12]. With the rapid increase in the number of MOOCs, the quality of courses and educational effects are of concern. Following the 6 most popular courses among the three major MOOC platforms in the country, it analyzes and compares the four aspects of learning outcomes, course content, assessment methods, and interactive design. The optimized design results such as design play a certain reference role in improving the quality of the course [13]. The neural network method of particle swarm majorization is used to create a model for assessing the quality of education; compared to the traditional model for assessing the quality of BP neural network education, the particle swarm optimization neural

network education quality evaluation result is closer to the real value, avoiding reaching a local minimum and achieving for better performance evaluation [14]. Teaching online is an urgent way to ensure continuity of university education during the COVID-19 pandemic. In this special situation, it is urgent to research an effective online learning method and improve the quality of online education. As a new type of localized teaching method, PAD (Presentation, Assimilation, Discussion) mode has the significant advantages of in-depth concept, comfortable use, and significant learning effect. Based on the principle of the PAD model, its application in the online teaching of general psychology courses for general students during the COVID-19 epidemic is discussed, as well as the challenges faced by the online education of general psychology courses, the theoretical and practical basis of the application of the PAD model, and the PAD specific stage of the model's implementation in general psychology online education, and finally summarizes the issues that need to be considered when applying the PAD model to online teaching, including distinguishing students' learning characteristics, enhancing teachers' ability to manage classrooms, and improving the integration and optimization of educational resources [15].

2. Online Teaching Courses

2.1. Problems Existing in Online Courses. Online teaching courses can break the limitations of time and space and provide continuous and diverse course resources anytime, anywhere, which is a huge advantage that traditional courses cannot match. On the other hand, online teaching courses also have problems such as poor continuity of students' learning attention, fragmented learning exchanges, and insufficient interaction with education. However, colleges and universities often fail to see many of the differences between online teaching courses and traditional courses and do not have clear instructions on the specific development of learning activities. Therefore, many teachers do not follow the characteristics of online teaching courses, but follow the original teaching experience, which seriously affects education. In addition to teaching courses online, university teachers face challenges related to their own sources of knowledge, teaching methods, teaching skills, and use of information technology. Many teachers laughed at themselves and became "eighteen anchors," and some famous teachers and famous teachers have a strong "achievement" color in their teaching. Some teachers do not use experiential eLearning or create classroom lessons. All this requires teachers to improve their own skills. A more general problem is that teachers teach in the same way as in traditional classrooms, and online courses are less oversight of the learning process. Due to the lack of classroom restrictions in traditional teaching methods, students are easily distracted in online courses, which affects the learning effect. Online courses are usually organized into different modules according to the learning content and knowledge points, supplemented by short videos of about ten minutes. Students should browse and explore independently before and after class. Academic achievement largely depends on the self-discipline of students. As a result, online learning outcomes at the student level vary from person to person. Online courses lack elements such as teachers, classmates, and classroom discipline that can be used to drag students down. Students only look at computer screens and are easily distracted from study. Students' learning has changed from group learning to individual learning. There is no comparison, it is easy to slow down and procrastinate, and the learning efficiency is reduced. In addition, online team discussions for students after class can easily become on paper and cannot be conducted in person or with satisfactory results.

In online courses, learners' attention is not strong, the learning communication is scattered, and the teaching interaction is insufficient; the course setting is not prepared in advance, and the students do not preview in advance, and the classroom learning effect is reduced; in the teaching process of online courses, teachers cannot pass the network. The classroom platform sees the learning status of students. Even through live broadcast or barrage, the interaction between teachers and students is delayed. It is impossible to grasp students' thoughts and behaviors in the first place, and teachers' management and supervision functions in the classroom are correspondingly weakened; due to the lack of traditional classroom constraints of the teaching form, students are easily distracted during the online course learning process, which affects the learning effect.

2.2. Factors Influencing the Quality of Online Teaching Courses. The quality assurance system of online teaching courses is based on the whole process of online courses, including the main factors and some hidden elements that influence the quality of online teaching courses. Linking issues can affect the quality of the entire online course, which in turn affects learning outcomes. Therefore, only by analyzing all aspects of the entire course can a scientific online course quality assurance system be finally constructed. The curriculum concept is the forerunner of curriculum design. For online education, the concept of creating courses based on workflow has become the core concept of education, and open online courses in colleges should be matured around this concept. Colleges and universities mainly cultivate students' professional skills, and it is clear that the positioning of online courses is to cultivate skills; the course design is based on the actual job process, and the content of online courses is clearly constructed according to the tasks of the work process; the educational method of organizing courses is based on behavior or design, specifying strategies for implementing online courses. Explaining the concept of an online course is the starting point for quality assurance. Course resources and content are the cornerstone of online course quality assurance. Due to changes in teaching forms, online courses have put forward new standards and requirements for the form and content of resources. In particular, with the development of the mobile net, the construction of online course resources has become "easy to spread." Therefore, "microengraving" has become the main form of programming resources in recent years. At the same time, with the development of microcourses, the organizational

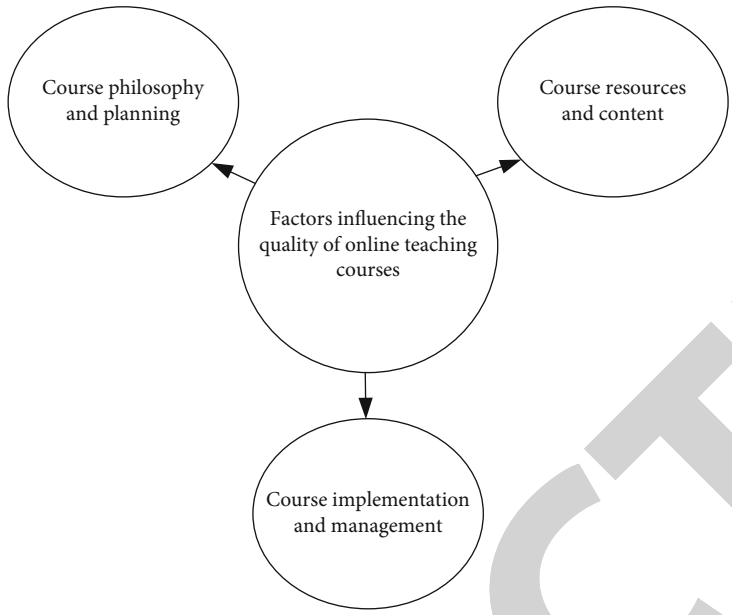

Figure 1: Factors influencing the quality of online teaching courses.

form of course content has changed, especially in education. In addition to the above behavioral concepts, "granular" teaching content has become the mainstream, and the creation of a quality online course guarantee system focuses on creating course resources and content. The key to building an online course is course implementation and management, which is the way to embody the course idea and the form of delivery of course resources. The online form of higher education has essentially broken through the traditional teaching method and is no longer a knowledge transfer in the context of professional embodiment. Therefore, the implementation of online open courses in colleges and universities is based on behavior orientation, the use of message technology, and the use of online learning platforms. In this process, we must not only persist in the basic principles of teaching but also take into account the laws of network communication to ensure the quality of the course, as shown in Figure 1.

2.3. Construction Principles of Online Teaching Course Guarantee System. Since in the organization of the whole project, as a factor that affects different cities, it is essential to fully consider the elements that affect the comprehensive achievement education, the factors that affect different aspects, throughout the entire online course and the most important aspect, the design of the comprehensive aspects online can be emphasized by emphasizing emphasized and displayed with different emphasis. Build the basic guarantee system of the curriculum quality system. The establishment of a quality assurance system is only a basic institutional requirement, and it is also a standard system. Integration and features ensure the sexual development of course content and a mature quality assurance system. If an excellent and scientific quality assurance system cannot be implemented, if the operation of the system cannot be guaranteed, the operation of the operating system cannot be guaranteed, and an empty system shelf cannot be guaranteed. Proposing and acknowledging that such developments are fully guaranteed, targeted activities and the quality of activities are the principles of the system, as shown in Figure 2.

2.4. Optimization Strategies for Online Teaching Tutorials. At this stage, "large-scale, interactive online education" enables teachers to provide thousands of students with high-quality education in a real-time, interactive, remote, and decentralized way. The educational philosophy requires and guides teachers and students to carry out online course work. Many students do not have time to bring their textbooks home, or the school does not distribute textbooks, and students do not review reference materials, which affects the effect of online courses. In view of more than questions, so as to achieve the teaching goal of the trinity of value counseling, training technical skills and theoretical knowledge transfer, the information security technology course teaching content of group planning is the basic theory of information security and the application of information security in the compilation of textbooks. There are 3 sections of technical engineering and information security, which conform to the 3 dimensions of learning research, technical research, and practical examples. Configured online learning resources. Tutorials, intermediate knowledge explanation rules and advanced problem discussion applications allow students to expand and read other online resources after self-study online. Students can use sufficient online teaching materials for preview review, which is conducive to easier mastery of the course. Compared with traditional face-to-face classroom teaching, online teachers cannot see the performance of students in time, and it is difficult to keep abreast of students' learning status. Students are easily distracted from learning because they do not have to look at the teacher and are not confined to the classroom. Therefore, timely and effective online interaction is the most major link

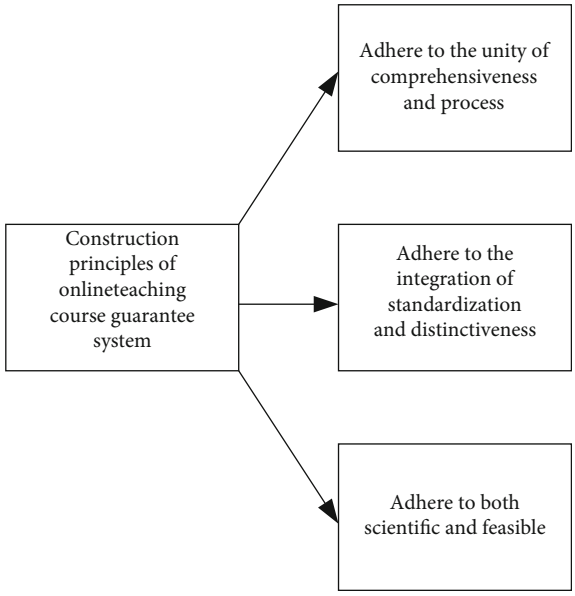

Figure 2: Construction principles of the online teaching course guarantee system.

to improve the quality of online education. For this reason, the information security technology group course starts with language scripts and multimedia audiovisual tools to improve the organization ability of online discussion and answering questions. The course team also set up online. Various data collection channels such as video assessment, synchronous chapters, and self-assessment are used to understand students' learning difficulties and common problems. In addition, continuous education feedback can be obtained through platform questionnaires, hiring students and teachers, etc. It needs to be improved. According to the stratified and segmented assessment methods, research and understand the learning outcomes of students at each stage, and check and fill in the blanks. In the offline epidemic prevention and control exam, in order to strengthen the connection of knowledge points learned by online students and solve the problem of fragmentation of knowledge content, the course group. It further emphasizes the requirement of "integration" and proposes a course report to solve complex problems and technical problems related to information security. From macro to micro, it helps students solve knowledge problems and establishes an online education model that resonates synchronously and asynchronously, as shown in Figure 3.

3. Machine Learning Models

3.1. Factor Analysis

3.1.1. Standardize the Original Data. Since the factor analysis is obtained from the covariance matrix S and the covariance matrix is affected by the dimension and quantity of the rank index, different dimensions and orders of magnitude will obtain different covariance matrices, so the factor analysis by the rank index will also be affected. Metrics vary in dimension and size, so the raw data must be normalized. In general, the formula to normalize the z-score is

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{S_j}. \tag{1}$$

In the formula,

$$\bar{x}_j = \frac{1}{n}\sum_{i=1}^{n} x_{ij}, \tag{2}$$

$$S_j^{\,2} = \frac{1}{n-1}\sum_{i=1}^{n}\left(x_{ij} - \bar{x}_j\right)^2. \tag{3}$$

Since the covariance matrix of the standardized index is equal to its correlation coefficient matrix and the correlation coefficient matrix is not affected by the index dimension or quantity set, the standardized factor formula is not affected by the dimension and quantity set.

3.1.2. Calculate the Covariance Matrix of the Standardized P Indicators. The correlation coefficient matrix is

$$R = \left(r_{ij}\right) r_{ij}. \tag{4}$$

At this time, the calculation formula of the correlation coefficient matrix R is

$$r_{ij} = \frac{s_{ij}}{\sqrt{s_{ii}}\sqrt{s_{jj}}}, \tag{5}$$

$$s_{ij} = \frac{1}{n-1}\sum_{i=1}^{n}\left(x_{1i} - \bar{x}_i\right)\left(x_{1i} - \bar{x}_j\right). \tag{6}$$

3.1.3. Calculate the Eigenroot and Eigenvector of the Correlation Matrix R. The p eigenvalues $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_p \geq 0$ and the corresponding eigenvectors $a_1, a_2, \cdots, a_p$ of the R matrix are obtained by the Jacobi method, where the formula for ζ_i is as follows:

$$\zeta_i = \left(\zeta_{i1}, \zeta_{i2}, \cdots, \zeta_{ip}\right)', \quad (i = 1, 2, \cdots, p). \tag{7}$$

λ_i is the variance of the i-th main factor y_i, which reflects the role of the i-th main factor y_i in describing the object being evaluated.

3.1.4. Calculate the Variance Contribution Rate a_k and Cumulative Variance Contribution Rate $a(k)$ of Each Common Factor. The variance contribution rate of the k^{th} common factor y_k is

$$a_k = \frac{\lambda_k}{\sum_{i=1}^{p}\lambda_i}. \tag{8}$$

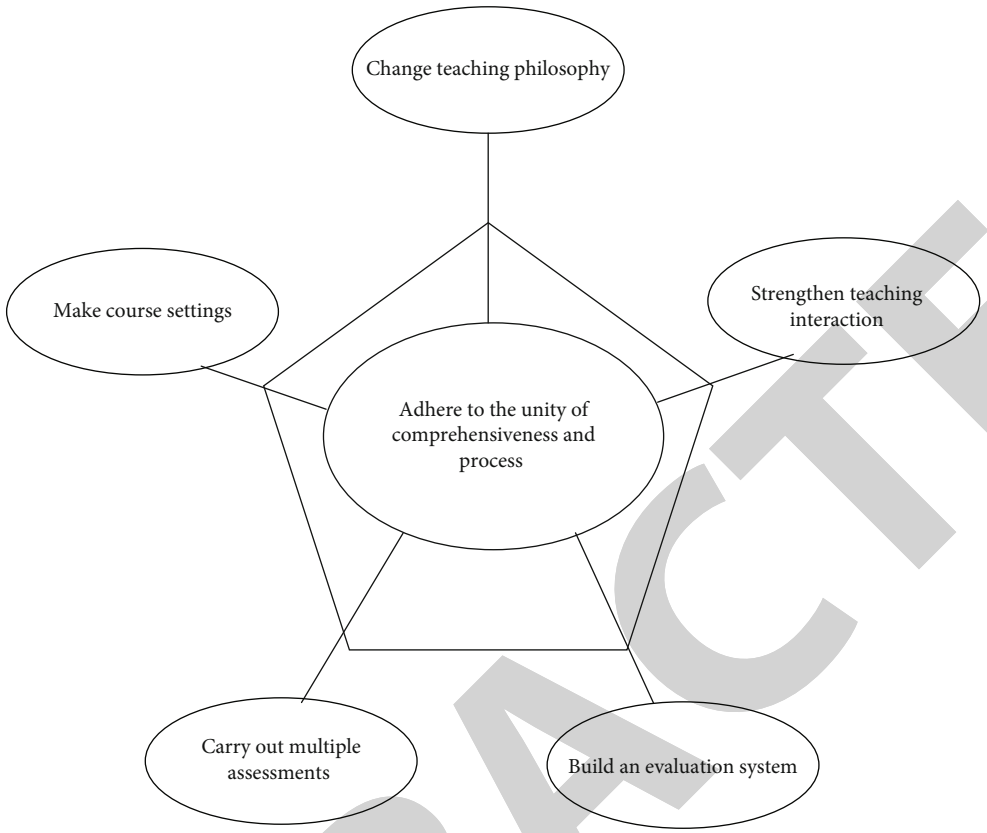

Figure 3: Optimization of online teaching courses.

The cumulative variance contribution rate of the first k common factors $y_1, y_2, \cdots, y_p$ is

$$a_k = \sum_{k=1}^{k} \frac{\lambda_j}{\sum_{i=1}^{p} \lambda_i}. \tag{9}$$

y_k's variance contribution rate a_k represents

$$\text{var}\,(y_k) = \lambda_i. \tag{10}$$

The total variance in the original indicator is

$$\sum_{i=1}^{p} \text{var}(x_i) = \sum_{i=1}^{p} \text{var}(y_i) = \sum_{i=1}^{p} \lambda_i. \tag{11}$$

The proportion of the total variance of the original index is the information amount of the original p index extracted by the kth common factor. Therefore, the cumulative variance contribution rate $a(k)$ of the k common factors y_1, $y_2, \cdots, y_k$ represents the total amount of original information retained by the k common factors.

3.1.5. Determine the Number of Common Factors. The more common ones in practice are as follows.

The first is the principle of cumulative contribution rate. According to the actual needs of the problem, the cumulative variance contribution rate of the first k common factors can meet certain requirements, usually $a(k) \geq 85\%$.

The second is the principle of averages. That is, calculate the average of p eigenvalues.

$$\bar{\lambda} = \frac{1}{p} \sum_{i=1}^{p} \lambda_i. \tag{12}$$

Then, compare each feature root λ_i with $\bar{\lambda}$, and if $\lambda_i > 1$ is satisfied, it can be selected.

For normalized data, there are

$$\sum_{i=1}^{p} \lambda_i = p. \tag{13}$$

The minimum k value that satisfies $\lambda_i > 1$ is required. The common factors of this principle are selected less.

The third is the Bartlett hypothesis test to determine the number of common factors. This method has a large amount of calculation and is rarely used in practice.

(1) The principle of cumulative contribution rate: according to the needs of the actual problem, the cumulative variance contribution rate of the first k common factors can meet certain requirements

(2) The principle of mean

(3) Bartlett's hypothesis test to determine the number of common factors

3.1.6. Calculate the Initial Factor Loading Matrix. The initial factor loading matrix is

$$A = (a_{ij}), \tag{14}$$

where,

$$a_{ij} = \sqrt{\lambda_j}\zeta_{ij}(15), \quad (i = 1, 2, \cdots, p\,; j = 1, 2, \cdots, m). \tag{15}$$

This step is actually solving the factor model:

$$Z = AF, \tag{16}$$

where,

$$z = (z_1, z_2, \cdots, z_p)', \tag{17}$$

$$F = (F_1, F_2, \cdots, F_m). \tag{18}$$

3.1.7. Calculate the Inverse of the Correlation Matrix R and Estimate the Factor Scores. Express p indicators $x_1, x_2, \cdots, x_p$ as a linear combination of m common factors:

$$x_i = a_{i1}F_1 + a_{i2}F_2 + \cdots + a_{im}F_m. \tag{19}$$

Since the common factor can fully reflect the internal dependence of the original index, it is better to have a deeper understanding of the object being scored when using the common factor to represent the original index. Therefore, it is often necessary to convert m common factors into a linear combination of p original indicators and calculate the common factor score of each sample; the formula is defined

$$F_j = \beta_{j1}x_2 + \cdots + \beta_{jp}x_p. \tag{20}$$

Since the m equations in equation (19) are less than p numbers, the factor scores can only be estimated in the form of least squares. Thomson assumes that m common factors can be regressed to any p-exponent, that is, establishes a regression equation:

$$F_j = \beta_{j0} + \beta_{j1}x_2 + \beta_{j2} + \cdots + \beta_{jp}x_p. \tag{21}$$

Since the indicators and common factors are standardized, there is $\beta_{j0} = 0$.

The Thomson factor score estimation formula estimated by least squares is

$$\widehat{F} = A'R^{-1}X. \tag{22}$$

3.1.8. Finding Total Factor Score Estimates.

$$\widehat{F} = \sum_{i=1}^{m} \omega_{ii}, \tag{23}$$

where ω_{ii} is the normalized weight of the i-th common factor F_i:

$$\omega_{ii} = \frac{\lambda_i}{\sum_{j=1}^{m}\lambda_i}. \tag{24}$$

Finally, according to the estimated value of the total factor score, each evaluated object can be sorted, classified and compared. The calculation process is as follows.

Step 1: standardize the original data to eliminate the influence of the dimension and order of magnitude of the indicators.

Step 2: calculate the correlation coefficient matrix R of the standardized indicators.

Step 3: use the Jacobi method to find the eigenvalues of R and its corresponding eigenvectors.

Step 4: determine the number of common factors: select the number m of characteristic roots greater than or equal to 1 as the number of common factors, or determine m according to the criterion that the cumulative variance contribution rate is equal to or equal to 85%.

Step 5: calculate the initial factor loading matrix.

Step 6: explain the actual meaning of common factors.

Step 7: calculate the inverse matrix of the correlation coefficient matrix R, and estimate the factor score of each evaluated object.

Step 8: seek comprehensive value.

Step 9: according to the estimated value of the total factor score, each evaluated object can be sorted, classified, compared, and analyzed.

3.2. ANP Model

3.2.1. Weighted Hypermatrix. The weighting matrix is the core, and the formula is

$$A = \begin{bmatrix} a_{11} & \mathrm{L} & a_{1N} \\ \mathrm{M} & \mathrm{O} & \mathrm{M} \\ a_{N1} & \mathrm{L} & a_{NN} \end{bmatrix}. \tag{25}$$

Observe whether the diagonal of the weighted super matrix has a value of 0; if it does, it means that the weight of the feature will eventually be 0.

3.2.2. Limit Hypermatrix Features. The limit super matrix is characterized in that the value of any row is the same, and the sum of each column is still 1. The formula is

$$W^{\infty} = \lim_{x \longrightarrow \infty} W^k. \tag{26}$$

Based on the interaction between the elements in the network model, make a pairwise comparison. Determine the unweighted super matrix (based on the pairwise judgment matrix, use the eigenvector method to obtain the normalized eigenvector value, and fill in the super matrix column vector). Determine the weight of each element group in the super matrix (to ensure that each column is normalized). Calculate the weighted super matrix. Calculate

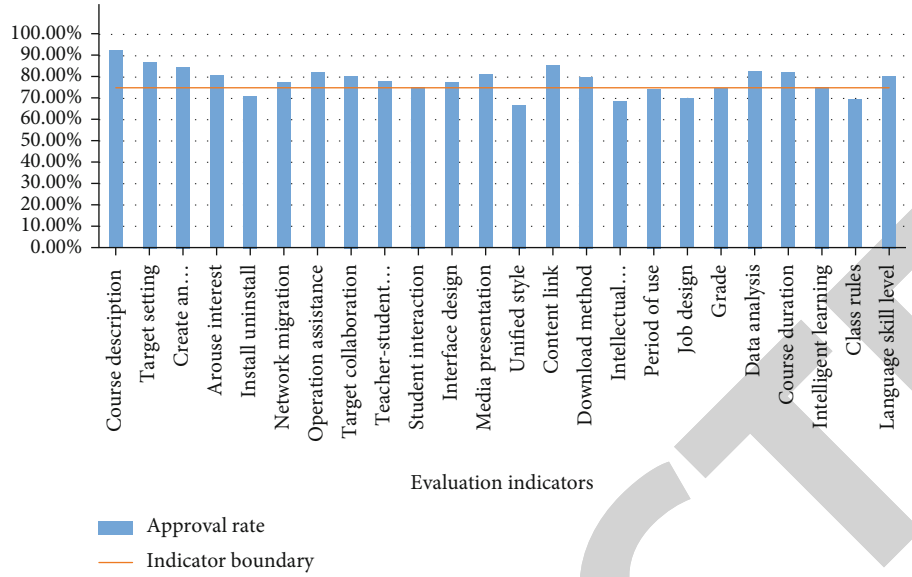

Figure 4: The main factors for selecting the quality of online teaching courses.

the limit super matrix (use the power method, that is, find the nth power of the super matrix until the column vectors of the matrix remain unchanged).

4. Evaluation and Analysis of Online Teaching Course Quality Based on Machine Learning Model

In order to reduce random errors, this survey randomly selected 4 colleges and universities to distribute questionnaires to colleges and universities of different levels. Each school distributed 90 copies, a total of 360 questionnaires were distributed, 301 copies were successfully recovered, and the effective recovery rate was 83.61%. Data were analyzed.

4.1. Construction of Basic Information and Evaluation Index System. A total of 24 evaluation indicators have been set up. Statistical analysis is carried out through the questionnaire data, and the evaluation indicators with a recognition rate of more than 75% are selected for the subsequent analysis. From the figure, we can see that there are 18 indicators whose recognition rate is greater than or equal to the limit of the indicators, which are courses, respectively: description, environment creation, goal setting, interest stimulation, goal collaboration, network migration, teacher-student interaction, operation assistance, interface design, student interaction, content connection, media presentation, download method, course duration, performance evaluation, intelligent learning, data analysis, and language level. Those with an approval rate of less than 75% included installation and uninstallation, style uniformity, intellectual property rights, term of use, homework design, and classroom discipline. Their approval rates were 71.40%, 67.20%, 68.90%, 74.80%, 70.20%, and 69.70%, respectively, as shown in Figure 4.

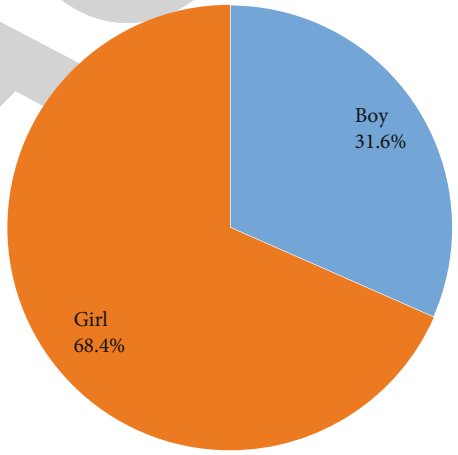

Figure 5: Gender distribution.

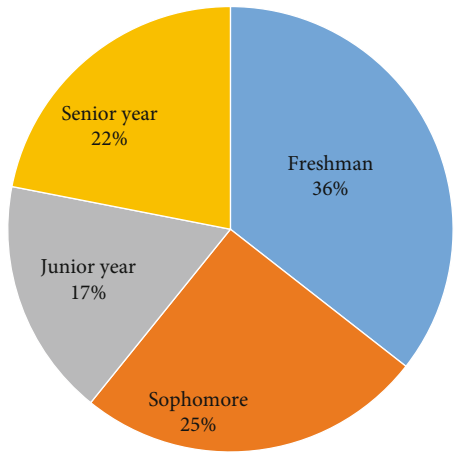

Figure 6: Grade distribution.

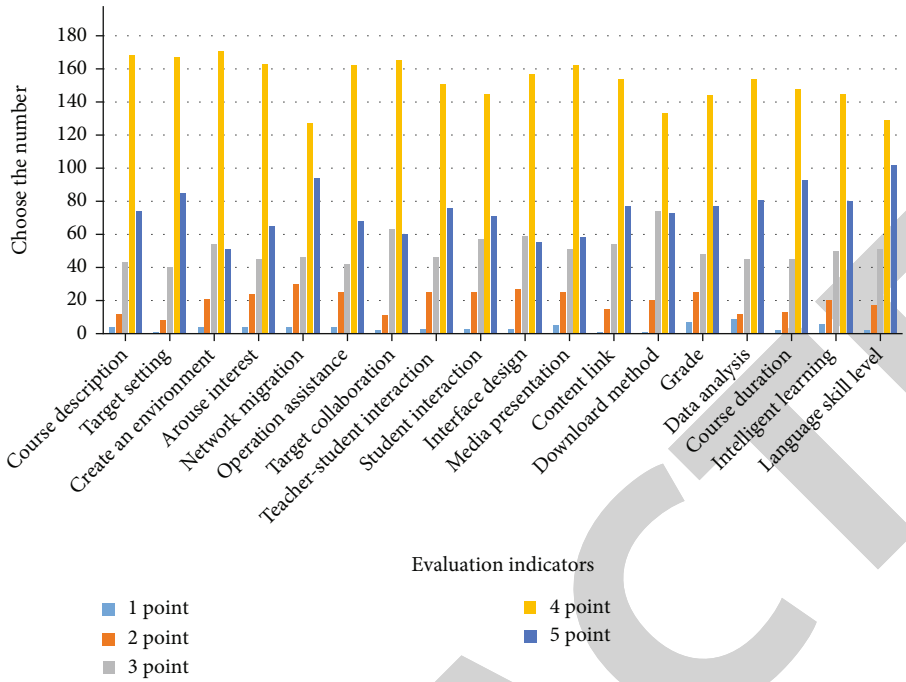

Figure 7: Scoring of evaluation indicators.

The gender distribution of valid questionnaires was that girls were more than boys. Boys accounted for 31.6% of the total number and girls accounted for 68.4% of the total number, as shown in Figure 5.

As can be seen from Figure 5, there are 107 freshmen, accounting for 35.5%; sophomores are 76, accounting for 25.3%; juniors are 52, accounting for 17.30%; seniors are 66, accounting for 25.3%, as shown in Figure 6.

The most selected evaluation index is 4 points, and the least is 1 point. In the course description, there are 4 people who choose 1 point, 2 people who choose 2 points, 43 people who choose 3 points, 168 people who choose 4 points, and 74 people who choose 5 points. In the goal setting, there is 1 person who chose a score of 1, 8 people who choose a score of 2, 40 people who choose a score of 3, 167 people who choose a score of 4, and 85 people who choose a score of 5. There are 4 people who choose 1 point, 21 people who choose 2 points, 54 people who choose 3 points, 171 people who choose 4 points, and 51 people who choose 5 points. There are 4 people who choose 1 point, 24 people who choose 2 points, 45 people who choose 3 points, 163 people who choose 4 points, and 65 people who choose 5 points. There are 4 people who choose a score of 1, 30 people who choose a score of 2, 46 people who choose a score of 3, 127 people who choose a score of 4, and 94 people who choose a score of 5; in the operation help, there are 4 people who choose 1 point, 25 people who choose 2 points, 42 people who choose 3 points, 162 people who choose 4 points, and 68 people who choose 5 points. There are 2 people who get a score of 1, 11 people who choose a score of 2, 63 people who choose a score of 3, 165 people who choose a score of 4, and 60 people who choose a score of 5. There are 3 people who choose a score of 1, 25 people who choose a score of 2, 46 people who choose a score of 3, 151 people who choose a score of 4, and 76 people who choose a score of 5, as shown in Figure 7.

Goal setting had the highest average score, with an average score of 4.09, followed by course length, with an average score of 4.05, language proficiency, with an average score of 4.04, course description, with an average score of 3.98, content linkage, with an average score of 3.97. The average score of network migration is 3.92; the average score of intelligent learning is 3.91; the average score of target collaboration is 3.9; the average score of teacher-student interaction is 3.9; the average score of operation assistance is 3.88; the average score of interest stimulation is 3.87; the average score of student interaction is 3.85; the average score of download method is 3.85; the average score of environment creation is 3.81; the average score of media presentation is 3.81; the average score of interface design is 3.78, as shown in Table 1.

4.2. Factor Analysis Method. The KMO and Bartlett tests were performed on the questionnaire data, and it could be seen that the KMO sampling suitability measure was 0.876 greater than 0.8, so the relationship between the variables was good, and it was suitable for factor analysis, as shown in Table 2.

As can be seen from the table, the first factor includes data analysis, performance evaluation, intelligent learning, course duration, and language level named as course analysis; the second factor includes network migration, operation assistance, content connection, and download method named as course support; the third factor is course description, environment creation, goal setting, and interest stimulation, which is named curriculum preset; the fourth factor is student interaction, media presentation, goal collaboration, interface design, and teacher-student interaction, named curriculum interaction, as shown in Table 3.

Table 1: The average score of each index.

Evaluation indicators	The average score
Course description	3.98
Target setting	4.09
Create an environment	3.81
Arouse interest	3.87
Network migration	3.92
Operation assistance	3.88
Target collaboration	3.9
Teacher-student interaction	3.9
Student interaction	3.85
Interface design	3.78
Media presentation	3.81
Content link	3.97
Download method	3.85
Grade	3.86
Data analysis	3.95
Course duration	4.05
Intelligent learning	3.91
Language skill level	4.04

4.3. ANP Model. In the secondary indicators, the CR value of course preset is 0.06529; the CR value of course interaction is 0.06368; the CR value of course support is 0.0748; the CR value of course analysis is 0.036. According to the rules of consistency test, the CR values of the secondary indicators are all less than 0.1, so all the judgment matrices meet the requirements, as shown in Table 4.

The figure shows intuitively that the teacher-student interaction in the course interaction has the highest ANP value, with an ANP value of 0.264721; the lowest is the course duration in the course analysis, with an ANP value of 0.006085; in the course presets, the highest ANP value is interest excited, the ANP value is 0.121398, followed by the course description ANP value of 0.06009, the goal setting ANP value of 0.031365, and the curriculum analysis ANP value of 0.014004; in the course interaction, the largest ANP value is the teacher-student interaction, and the ANP value is 0.264721. The ANP value of media presentation is 0.154391, the ANP value of target collaboration is 0.084266, the ANP value of class-student interaction is 0.047685, and the ANP value of interface design is 0.033207; in course support, the largest ANP value is operation assistance, and the ANP value is 0.039793, followed by network. The ANP value of migration is 0.030863, the ANP value of download mode is 0.027683, and the ANP value of content connection is 0.012347; in the course analysis, the largest ANP value is intelligent learning, the ANP value is 0.045928, followed by the data analysis ANP value of 0.01136, the language standard ANP value is 0.008374, and the performance evaluation ANP value is 0.006441; the course duration ANP value is 0.006085, as shown in Figure 8.

On the whole, it can be seen that teacher-student interaction, media presentation, and interest stimulation are the three factors with higher weights in order, while the three factors of performance evaluation, course duration, and language proficiency have relatively low weights. In the course presets, the highest weight is interest stimulation, and the smallest weight is environment creation; in the course interaction part, the global weight is the teacher-student interaction, and the smallest weight is the interface design; in the course support, the largest weight is an operation aid, and the content connection has the smallest weight; in the course analysis part, the weight of intelligent learning is the highest, and the weight of the course duration is the lowest.

It can be seen from the table that in the second-level indicators, the evaluation score of course interaction is the lowest, with a score of 3.91, and the course support is the highest, with a score of 4.02. In the third-level indicators,

Table 2: KMO and Bartlett's test.

KMO sampling suitability quantity	0.876	
Bartlett's sphericity test	Approximate chi-square	1497.685
	Degrees of freedom	153
	Salience	0

Table 3: Composition matrix after rotation.

	Element			
	1	2	3	4
Data analysis	0.738	0.135	0.098	0.134
Grade	0.666	-0.015	0.057	0.297
Intelligent learning	0.619	0.14	0.115	0.242
Course duration	0.503	0.38	0.189	-0.021
Language skill level	0.481	0.17	0.267	0.071
Network migration	0.063	0.76	0.187	0.18
Operation assistance	0.116	0.684	0.12	0.276
Content link	0.393	0.559	0.099	0.095
Download method	0.178	0.549	0.075	0.355
Course description	0.174	0.258	0.778	0.078
Environment creation	0.193	-0.005	0.688	0.206
Target setting	0.247	0.363	0.683	-0.081
Arouse interest	-0.08	-0.031	0.563	0.559
Student interaction	0.247	0.208	-0.04	0.624
Media presentation	0.331	0.13	0.115	0.584
Target collaboration	-0.003	0.356	0.24	0.53
Interface design	0.258	0.284	0.042	0.446
Teacher-student interaction	0.304	0.179	0.286	0.398

Table 4: Corresponding CR values of secondary indicators.

Secondary evaluation index	Course preset	Course interaction	Curriculum support	Course analysis
CR	0.06529	0.06368	0.0748	0.036

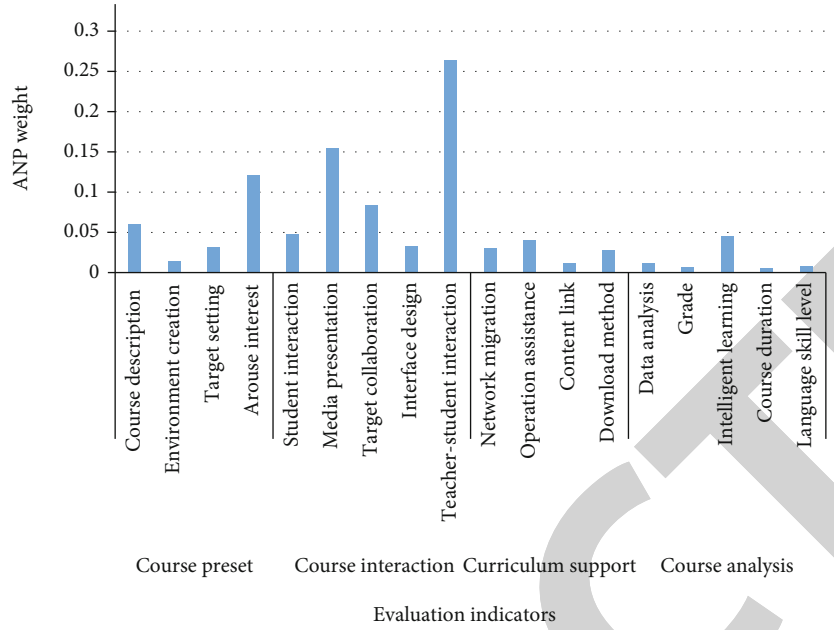

Figure 8: Global weight of online teaching course quality evaluation indicators.

Table 5: Average scores for each indicator.

Control layer	Secondary indicators	Evaluation score	Three-level indicator	Evaluation score
Quality of online teaching courses	Course preset	3.98	Course description	4.07
			Environment creation	3.83
			Target setting	4.16
			Arouse interest	3.87
	Course interaction	3.91	Student interaction	3.93
			Media presentation	3.9
			Target collaboration	3.94
			Interface design	3.84
			Teacher-student interaction	3.93
	Curriculum support	4.02	Network migration	4.05
			Operation assistance	3.98
			Content link	4.07
			Download method	3.96
	Course analysis	4.01	Data analysis	4.01
			Grade	3.87
			Intelligent learning	3.94
			Course duration	4.15
			Language skill level	4.08

environment creation has a low score, with a score of 3.83, interface design. The score was 3.84, interest stimulation, 3.87; performance evaluation, 3.87; relatively high scores were language proficiency, 4.08; course description, 4.07; goal setting, 4.16; and content connection, 4.07. Clearly, the low-scoring part of the course interaction is the most important aspect when developing our proposed strategy. At the same time, stimulating interest, creating environment, performance evaluation, and interface design are also important factors for us to improve the quality of online courses, as shown in Table 5.

5. Conclusion

The study found that students pay more attention to interest stimulation, but the score of interest stimulation is relatively low; the presentation method of media is an important factor affecting the quality of online teaching courses; teacher-

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Retraction

Retracted: Markov Model-Based Sports Training Risk Prediction Model Design and Its Training Control

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] H. Huang and S. Wen, "Markov Model-Based Sports Training Risk Prediction Model Design and Its Training Control," *Journal of Sensors*, vol. 2022, Article ID 9368686, 10 pages, 2022.

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Research Article

Markov Model-Based Sports Training Risk Prediction Model Design and Its Training Control

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With the improvement of living standard, people gradually start to pay attention to physical health and figure maintenance, and sports training also gradually becomes a hot issue for people. Sports training can help people develop a healthy body and cultivate a persevering spirit, which can be of great help in all aspects of people's development, but sports training also has a certain degree of risk, and only a reasonable response can make sports training give maximum value. In this paper, a Markov model is established, a probability transfer matrix is calculated, and this matrix is used to predict the risks arising from sports training since the statistical decade, and the risks of sports training in the next three years are predicted, and some suggestions are made for how to minimize and avoid the risks.

1. Introduction

Physical training refers to a physical activity training that is aimed at physical and mental recreation, physical strengthening, health maintenance, and physical development by means of a variety of sports, combining health measures and natural forces such as air, water, and sunlight, and is a training that strengthens people's bodies, develops their perseverance and character, and helps them learn skills, not only for military personnel but also for all kinds of people who want to strengthen their bodies and sharpen their will which has an important significance. With the improvement of living standards, people's requirements for health are also getting higher and higher, and people begin to pursue a healthy body, a fit body; sports training activities also came into being; sports training can not only help people learn sports knowledge, exercise, and strengthen their bodies but also promote the metabolism of the cardiovascular system and respiratory system and other body functions and organs, more cultivate people's willpower, and make people become happy, and it also promotes the development of mental health [1].

The Markov model is a statistical model with a wide range of applications in the fields of speech and word recognition and identification, model prediction and analysis, and engineering design and manufacturing. The Markov model is a large concept; from the definition and nature of the model, stochastic processes or stochastic models with Markov properties and based on stochastic processes are collectively referred to as Markov models [2]. These include, for example, Markov chains, Markov decision processes, Hidden Markov Chains (HMM), and other stochastic processes or stochastic models. From the definition of Markov models, two main key words are important: stochastic process and Markovianity. The property that the conditional distribution of the state of a process or system at moment $t0$ is known, and the state of the process at moment $t > t0$ is independent of the state of the process before moment $t0$ and is Markovianity, also called posteriority-free. Simply put, a Markov process is a process in which the "future" state is independent of the "past" state. A stochastic process with Markovianity is called a Markov process, and a Markov process with discrete time and state is a Markov chain [3].

As the quality of life has improved dramatically, the people's attention to sports training has also increased dramatically, and people actively use a variety of sports training methods to strengthen their bodies and promote physical health. However, trainers are more or less likely to encounter sports injuries during sports training, causing a greater burden on the body and therefore need to promptly identify the main causes of sports injuries and implement targeted recovery strategies [4]. This requires the organizers of sports training to investigate and evaluate the possible risks of sports training in the process of organizing sports training, to build a decision model for the risks arising from sports training, to use the analytical method of building Markov models, to predict the possible risks arising from sports training, and to improve the ability to assess the risks of sports training and the ability to make decisions to avoid risks, therefore to build a model to predict the risks arising from sports training. Therefore, more and more attention has been paid to the development of models for predicting and evaluating the risks arising from sports training and proposing solutions. The use of Markov models for risk prediction in sports training is a very accurate research method [5].

The risk management model in sports training consists of eight main aspects: firstly, internal environment and goal setting, secondly, risk identification and risk assessment, then risk countermeasures and control activities, and finally, information and communication and monitoring. These management models are for different management perspectives and are integrated in the whole management system of sports training [6]. The internal environment is the platform of the entire management system, and the internal environment is influenced by the "human" management philosophy and risk appetite, which determines the setting of risk management objectives; objective setting is the premise of risk identification, risk assessment, and risk countermeasures, and specific risk management strategies and processes must meet the requirements of risk management to achieve the risk management objectives. Risk identification, risk assessment, and risk countermeasures are the specific implementation processes of risk management, which are the refinement and execution of risk management objectives; in internal control, information and communication are the two elements that lubricate the unimpeded flow of all other elements; monitoring is the recontrol and reimprovement of the risk management system to maintain the systemic and up-to-date nature of the risk management system.

This paper is mainly based on the Markov model, the investigation and analysis of common training methods of sports training, and the establishment of the Markov model for the risks encountered in sports training and research and prediction of these risks and put forward some opinions on the control and optimization of training methods for the risks, in order to reduce the adverse effects of sports injuries, improve the comprehensive level of sports training, make the sports training results more effective, and bring positive impact on people's physical health, psychological health, and life goals to the maximum extent [7].

2. Literature Review

This paper focuses on the prediction of risks in sports training and the control of these risks through the development of Markov models, so we first introduce the current state of research on Markov models and some common research problems based on Markov models.

In 1906, mathematician A.A. Markov proposed a class of stochastic processes in which the "future" of a system is only related to the "present" and does not depend on the "past." The results obtained by such stochastic processes illustrate and generalize Huygens' principle of no posteriority. In 1926, Bernstein named this class of stochastic processes with no posteriority after Markov chains, which was the first use of Markov chains, the mathematical model of Markov chains. Based on the basic Markov model, various improved Markovs were derived, and the most widely used one is the class of functions defined by Guo et al. [8] called hidden Markov models.

Markov models have a good probabilistic underlying theory and an efficient and simple construction structure and are widely used in the fields of speech recognition, biological sequence analysis, image processing and computers, character recognition, financial data analysis, spatiotemporal data mining, and text information extraction. Given the current state, it consists of two aspects: firstly, for the observation model, the probability of issuing future information is independent of all previous states and issued information; on the other hand, for the state model, the probability of transferring the next step is independent of all previous states and issued information [9].

The following is an example of an application of the Markov model.

Markov models can evaluate the effectiveness of diabetes screening and prevention of cardiovascular disease in a population in a given region, with the process shown below: the highest quality of life without diabetes and cardiovascular disease is assumed, with a health utility value of 1, and the lowest quality of life corresponds to death, with a health utility value of 0. Quality-adjusted life years were calculated based on health utility values for each health state and state transition process accumulated over the course of disease progression [10]. Comparisons between groups were made using chi-square tests for categorical variables and t-tests for continuous variables, both using two-sided tests with significance level α taken as 0.05. Indicators for evaluating the effectiveness of screening strategies to prevent cardiovascular disease including the number of life years and QALYs available, the number of preventable cardiovascular disease episodes or all-cause deaths, and the corresponding number of people to be screened were calculated. Probabilistic sensitivity analysis was used to estimate the uncertainty in the incidence of diabetes, the sensitivity of the screening method, and the strength of the effect of the intensive intervention, with a random number set to 1. 10,000 simulations were performed, and 95% uncertainty intervals for the effect indicators were estimated from the distributions obtained from the probabilistic sensitivity analysis. This study suggests that systematic screening for diabetes in populations

in developed regions of China can reduce cardiovascular morbidity and all-cause mortality according to the latest available guidelines, but the gain in cardiovascular disease prevention effect is not significant if the starting age of screening is lowered from 40 to 35 years, and the risk factors of overweight or obesity need to be taken into account if the starting age of screening is lowered to 35 years in order to improve screening efficiency and public health. In practice, screening strategies should be chosen appropriately according to the level of economic development and resource input [11].

In addition, the Markov model can also be used to study and predict the fashionable color of textiles and to explore the change pattern of the fashionable color of daily textiles, so as to provide effective data support for guiding the R&D and design of daily textiles. As an important element in the process of home textile product design, color has its inherent characteristics, seasonality, and continuity. The color trend of home textile popular colors in recent years consists of 10 color components, which are green, blue, purple, red, yellow, blue-green, purple-blue, red-purple, yellow-red, and green-yellow [12]. Therefore, firstly, we analyzed the information of spring and summer colors released by the International Color Council between 2007 and 2013 and obtained the market share of each hue component in all colors over the years. Since the actual application of popular colors is subject to the interference of various factors, which may lead to noise in the obtained time-series data, it is difficult to ensure that the original 1D time-series data contains sufficient information for reconstructing the dynamical system, so here it is necessary to transform the 1D time-series data into multidimensional time-series data to generate training samples suitable for modeling. Then, suitable kernel functions and parameters are selected to train the SVR model, and finally, the obtained prediction model is used to predict the trend of textile fashion colors. It can be concluded that the coefficients of variation of purple-blue and blue-green are relatively small, indicating that their volatility is not very obvious. The coefficients of variation of other color shades are relatively large, showing that the changes of their corresponding colors have obvious volatility and present a highly nonlinear change relationship in the time series with a certain degree of randomness. The average relative error of the gray model for blue hue prediction is below 20%, and only the relative error of individual years is abnormal, and the overall prediction effect is good; after the correction of the Markov residual correction model, although the prediction error of 2011 is larger, the prediction accuracy of 2012 and 2013 is improved [13]. This also shows that the gray Markov prediction model has better trend extrapolation ability for trend prediction of home textile fashion colors than the single GM(1,1), which is more suitable for long-term prediction of home textile fashion colors [14].

The Markov model can also predict the number of fatalities caused by accidents, and the process is shown as follows: based on the information of national coal mine accident statistics, the data of coal mine accident fatalities are obtained. The national coal mine accidents from 2008 to 2019 were used as the original data to predict the number of coal mine accident fatalities in 2020-2022, to compare and analyze the accuracy of the prediction results of three gray models and to optimize the Markov model for the results with better prediction accuracy. The three models are gray model, dimensional gray model, and unbiased gray model [15]. Both the dimensional gray model and the unbiased gray model are optimized gray models. The dimensional gray model uses the prediction results of the gray model to update the data, which adds and utilizes new information in a timely manner, improves the whiteness of the gray interval, and is mainly used for medium- and long-term forecasting. The unbiased gray model can eliminate the limitations of bias and weak anti-interference ability inherent in the traditional gray model itself. The C and P values of the three gray models satisfy the condition of "$C < 0.35$, $P = 1$," which means that the accuracy level of the three gray models is "good" and the small error probability P value is 1. The average relative error ε value of the unbiased gray model is 0. 07186, which is the smallest among the three gray models. The unbiased gray model effectively eliminates the inherent bias of the data itself and effectively improves the accuracy of the prediction results [16]. The unbiased gray Markov model was used to predict the number of fatalities in coal mine accidents, and the predicted number of fatalities in coal mine accidents in 2021 was 170, which is very consistent with the overall development trend of stable improvement in China's coal mine safety production situation, continuous decline in serious safety accidents, and continuous decline in the number of accidents and fatalities [17].

In addition to the above model, the Markov model can also predict the time of road congestion. The Markov chain has powerful ability to predict the problem and choose the optimal route. The training set is used to obtain and analyze the real-time road congestion time to build the corresponding hidden Markov model, so as to predict the road congestion time in the next time period and analyze the optimal route. And the further improvement of Welch's algorithm, adding the study of the previous n moments of data at a certain moment improves the algorithm, making the training set parameters closer to the actual, with higher prediction accuracy and more powerful applicability. Generally speaking, the main factors affecting road traffic congestion are temperature, visibility, peak driving hours, traffic accidents, etc. According to the data of the "Comprehensive Traffic and Travel Data Open Cloud Platform", these factors are closely related to vehicle travel time. In this paper, the data is collected using a traffic microwave radar detector, RTMS, which is an online device used to observe real-time road conditions [18]. The RTMS detects objects in 2-meter levels in the direction of microwave beam emission, and with lateral mounting, the device is installed on roadside poles to keep the microwave projection perpendicular to the road, and the split-level beam can provide multiple detection areas for various road conditions. It measures the position of vehicles in the microwave projection area and enables the detection of traffic data such as traffic flow and vehicle travel time of multiple lanes by distance [19]. The prediction accuracies are 98.0%, 97.8%, 97.5%, 97.1%, and 96.3% during the experimental cycle, and the accuracies gradually level off.

From the above development process and modeling examples, it can be seen that the Markov model has very wide application value in practice, which also provides solid theoretical support and credible experimental results for the research of this paper [20].

3. Establishment of the Markov Model and Prediction of Sports Training Risk

3.1. Establishment of the Markov Model. The Markov model is a stochastic time series analysis method, which predicts the future state of things by studying the initial probability of different states and the transfer probability between states. The most important feature of the Markov model is that it has no posteriority; that is, it is considered that the conditional distribution of the state of the process or system at the moment $t > t0$ is independent of the state of the process before the moment $t0$, if the state at the moment $t0$ is known. That is, the future state does not depend on the past but is only related to the current state. This property is very suitable for analyzing data with high volatility and no obvious time-varying characteristics.

3.1.1. Markov Process. Let $X = (X1, X2, X3, \cdots, Xt)$ be a sequence of random variables, where each random variable takes values in a finite set $S = \{s1, s2, s3, \cdots, sn\}$, called the state space. Markov is characterized by the following.

(1) Finite history assumption

$$P(X_{t+1} = s_k \mid X_1, \cdots, X_t) = P(X_{t+1} = s_k \mid X_t). \tag{1}$$

(2) Time invariance assumption

$$\forall i \in \{1, 2, 3, \cdots, T\} \forall x, y \in S, P(X_i = y \mid X_{i-1} = x) = p(y \mid x). \tag{2}$$

If X has these characteristics above, then this sequence of X is called a Markov process (chain).

If this sequence is a Markov chain, it has the $n \gg 0$ following $i, j \in I$, properties for all $p_{ij}^{(n)}$ integers and n-step transfer probabilities.

$$\begin{aligned} p_{ij}^{(n)} &= \sum_{k \epsilon I} p_{ik}^{1} p_{kj}^{(n-1)}, \\ P\{X(n_1) = i_1, X(n_2) = i_2, \cdots X(n_m) = i_m\} &= \sum_i p_i^{(0)} p_{ii_1}(n_i) p_{i_1 i_2}(n_2 - n_1) \cdots p_{i_{m-1} i_m}(n_m - n_{m-1}), \\ P^{(n)} &= P^{(n-1)} P. \end{aligned} \tag{3}$$

3.1.2. Markov Analysis Method. The basic model of Markov analysis is

$$X(K+1) = X(K) \times P, \tag{4}$$

where $X(K+1)$ denotes the state vector of the trend $T = K$ analysis and prediction object at P the moment, denotes the one-step transfer probability $X(K+1)$ matrix, and denotes the state vector of the $T = K + 1$ trend analysis and prediction object at the moment.

Let $p_{ij} = P(X_i = j \mid X_0 = i), i, j \in I$, and then p_{ij} be called transfer probability, which denotes the transfer probability from state i to state j. The transfer p_{ij} probability matrix thought of as an element is shown as follows.

$$\mathbf{P} = \begin{pmatrix} p_{11} & \cdots & p_{1m} \\ \vdots & \ddots & \vdots \\ p_{m1} & \cdots & p_{mm} \end{pmatrix} = \left(p_{ij}\right)_{m \times n}. \tag{5}$$

If the Markov model is to be used to make a prediction about something, it is a very important prerequisite that such a thing must have Markovianity. Therefore, the thing needs to be tested first, and the test result is judged using χ^2. Assuming that the index series is divided into m states, the frequency of transformation of state i to state j is noted as f_{ij}, the transfer probability is p_{ij}, and the conditional probability of the state transfer frequency matrix is taken as the marginal probability. According $f_{ij}(i, j \in I)$ to the calculation of each column of the matrix, calculate all the elements and, finally, the division operation. The calculation formula is as follows.

$$\mathrm{P_j} = \frac{\sum_{i=1}^{m} f_{ij}}{\sum_{j=1}^{m} \sum_{i=1}^{m} f_{ij}}, \tag{6}$$

The formula for calculating the χ^2 statistic is as follows.

$$\chi^2 = 2 \sum_{j=1}^{m} \sum_{i=1}^{m} f_{ij} \left| \log \frac{p_{ij}}{P_j} \right|. \tag{7}$$

It should be noted here that the log in the equation is because $\ln x$ is often written as $\log x$ in programming.

The degrees of freedom are obtained by checking the table given the significant $\chi_\alpha^2((m-1)^2)$ level α. So $\chi^2 > \chi_\alpha^2[(m-1)^2]$, if then the test is passed.

3.1.3. Constructing the Multistep Transfer Probability Matrix. The calculation of the multistep transfer probability matrix requires the use of the C-K equation (Chapman-Kolmogorov equation), which is calculated as follows.

$$P(u + v) = P(u)P(v). \tag{8}$$

In the equation, if we make $u = 1$ and $v = n - 1$, then we can get the following recurrence $P(n) = P(1)P(n-1) = PP(n-1) = \cdots = P^n$ relation, so for the chi-square Markov chain, the n-step transfer probability matrix is equal to the nth power of the one-step transfer probability.

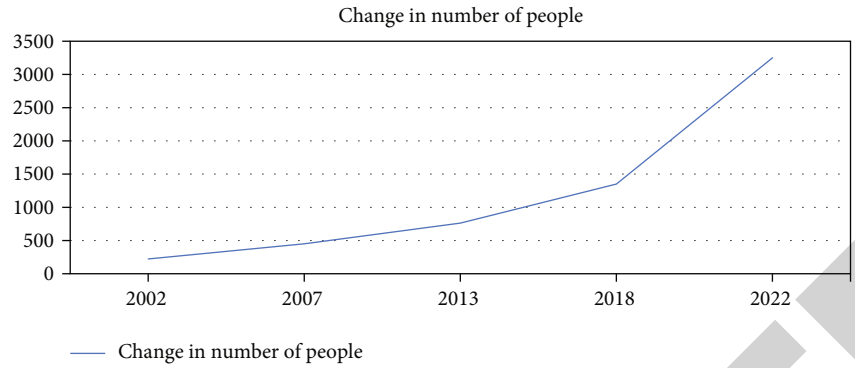

Figure 1: Statistical chart of the change of the number of people participating in sports training in the past 20 years.

3.1.4. Calculating the Invariant Probability Measure. For **P**, we can obtain a vector π such that $\sum_i \pi_i p_{ij} = \pi_j$ not $\pi_j \geq (\forall j)$ all π_j zero; then, π is called an invariant measure of P. And if $\sum_i \pi_i = 1$, then it is called an invariant probability measure.

It can be seen that the core problem of the Markov model is to determine the transfer probability matrix **P**. In this paper, we take unit year (one year) as the scale and investigate and count the different ways of sports training and the frequency of common risks occurring since the last decade, use it to construct the Markov model to predict the frequency of risks occurring in sports training in the next few years, and propose training improvement methods for each of these risks.

3.2. Analysis of Sports Training and Its Common Risks

3.2.1. The Necessity of Sports Training. With the improvement of people's living standard, people pay more attention to the health and shape of their bodies, and sports training has been paid more and more attention, and sports training becomes an indispensable basic sports ability for people after work and life. As shown in Figure 1, the number of people who participated in sports training in the twenty-year period from 2002 to 2022 has been increasing year by year and more and more rapidly.

First of all, the muscles in people's body are responsible for some basic functions of the body, such as walking, jumping, and weight-bearing; people rely on muscles to send food into the digestive system, and the movement of muscles helps people digest, absorb, and excrete; muscles through the mouth breathe in fresh air into the body and expel carbon dioxide gas; muscles throughout the body move to send blood to the vascular system from the head to the feet and expand and contract according to the demand. It can be said that all the basic functions of the human body need to rely on muscles to complete; therefore, to keep yourself healthy, you should first make all of your own muscles energetic; otherwise, the body will not be able to afford the basic daily needs; people need cardiovascular endurance and muscular endurance to work for a long time; to move heavy objects or fight against resistance, muscle strength is needed; to do a large range of activities in order to perform movements with a large range of motion, it is necessary to have flexible joints and strong stretching of muscles and ligaments.

Secondly, sports training helps people to master complex training movements, and the right sports training makes people get twice the result with half the effort. A very important feature of sports is that the sportsman needs to master the correct way of movement and skills, so that the results of sports can be shown on the human body. Different sports training programs have different degrees of requirements for trainers, and only when the trainer's training ability is improved in sports can the effect of sports training be improved.

Third, into the field for sports training which can improve the human body's ability to withstand large loads of training and high-intensity sports, for athletes such as the high physical requirements of the population, it is necessary to constantly improve their sports, and only frequent sports training exists to ensure the human body's ability to withstand the super-high requirements of training intensity; otherwise, the fatigue after training will be very serious, and the body's soreness is also unbearable. The body may even cause serious damage to internal organs, joints, etc.

Finally, sports training can help people maintain a stable and good mental state in daily training and competition. A large number of facts have shown that athletes with a stable and good mental quality in sports training competition is an important factor in achieving success and winning, because correct and safe sports training is a great way to form a stable and good mental state.

In general, sports training has a very significant meaning and role in comprehensively improving the quality of the nation, improving the health and sports level of all people, and cultivating good spiritual qualities of the people, and with the development of the times, strengthening sports training for all people has become an urgent task.

3.2.2. Analysis of the Common Ways of Sports Training and the Common Risks Caused. There are many types of sports training methods, which can be classified into the following categories from different exercise perspectives: endurance training programs, strength training programs, relaxation training programs, and corrective therapy programs.

Among them, endurance training programs are good for improving immunity and increasing the body's metabolism. This type of exercise includes medical walking, fitness running, bicycling, hiking, rope skipping, stair climbing, and

other items that belong to the periodic, rhythmic repetitive exercise. Strength training program exercises are good for muscle building and fat loss, slimming, and shaping and can target different body parts for different muscle training. Relaxation program exercise is mainly to relax the body and to reduce the busy or irregular work and rest bringing harm to the body and mind; you can choose to walk and do tai chi, health exercises, qigong, and massage. Corrective treatment programs are mainly targeted treatment; the main audience is some patients with physical diseases or disabilities, such as medical gymnastics and massage, such as breathing gymnastics for the treatment of asthma and emphysema, gymnastics for the treatment of sagging internal organs to exercise the abdominal muscles, and spinal correction gymnastics for the correction of scoliosis.

These different training methods also bring different risks, mainly divided into the following categories: training management risk, facility management risk, competition management risk, and trainer management risk.

Training management risk is the existence of various types of accidental risks in sports training, such as physical function damage, dangerous hazards, fainting, and sudden death. Once these risks occur, they will produce both physical and psychological trauma to the trainer and will also affect the development and progress of the economy. Facility management risk, as the name implies, is the safety risks in the construction of hardware facilities used for sports training, such as the construction of sports venues not meeting national quality standards, unreasonable design of sports tracks, which can cause sports injuries to trainers, and sports equipment quality being not up to scratch, causing injury to trainers. Competition management risk is the existence of various types of risks in sports competition, such as the lack of sportsmanship in the competition, the lack of awareness of rules, the lack of means to win the game, malicious fouls against opponents, increasing the athletes' sports injuries, and even intensifying the conflict between competitors. The risk of trainer management is that in sports management, trainers and coaches pay too much attention to the cultivation of ability and training results, ignoring the development of trainers' psychological health; in addition, some competitive sports training management has "secret operation," which is against fairness and causes athletes' resistance and questioning to competition. This increases the risk of sports management.

The probability of occurrence of the above-mentioned common sports training risks is shown in Figure 2.

From Figure 2, it can be seen that training management risk is the most probable risk in sports training, and this study will also focus on predicting and making recommendations for training management risk.

The steps for prediction of training management risk in sports training using the Markov model are shown in Figure 3. Firstly, the Markov transfer matrix needs to be established; secondly, the Markov transfer matrix is initially solved by using a statistical method, quadratic programming method, and other mathematical calculation methods; then, the results are normalized to obtain the transfer probability matrix, and finally, the probability matrix is analyzed and summarized.

The most common training management risk is the sports injuries that may occur during sports training. According to Sports Weekly, the types of sports injuries due to improper sports training from 2012 to 2021 were investigated, and there are four main types: muscle and tendon strains, joint injuries, heart injuries, and fractures. The trend graph of the changes in the risk due to the above four types of sports injuries since the last decade is shown in Figure 4.

In particular, it should be noted that since the total number of sports training people counted varies from year to year, the calculation of the impact caused by the risk of sports injuries is normalized.

Based on the preliminary understanding and regular analysis of the changes in the above sports injuries, the following assumptions can be made about the Markov model for predicting the risk of sports training.

(1) The four injury states are set as 1, 2, 3, and 4, respectively, for modeling

(2) The four sports injury states are transferred to each other in order, where the time of transferring one state to the adjacent state is set as unit year (data are counted by years)

(3) The transfer order was transferred from state 1 to state 2, state 2 to state 3, state 3 to state 4, and state 4 to state 1, respectively

For the analysis of the statistical graph of the risk caused by sports injuries during the last ten years, the number of transfers of the four sports injuries can be calculated, and the transfer probability matrix can be calculated by the formula. Using this transfer matrix, the risk of sports training in the latter three years, especially the risk of sports injury in training management risk, can be predicted, and the results obtained are shown in Figures 5–8, respectively.

4. Results and Discussion

From the above results, it can be seen that the risk of sports injury in sports training is decreasing year by year, among which the two injuries, joint injury and fracture, are decreasing faster, and the muscle tendon strain and heart injury are decreasing more slowly. The reasons for this are as follows.

(1) Joint injuries and fractures of these two types of injuries in addition to improper sports and sports training venues, the use of sports training equipment, and other aspects also have a great relationship. With the popularity of sports training and the increase in the number of participants in sports training, sports training venues are becoming more and more in line with the standards, equipment has also undergone various inspections and tests, and now more and

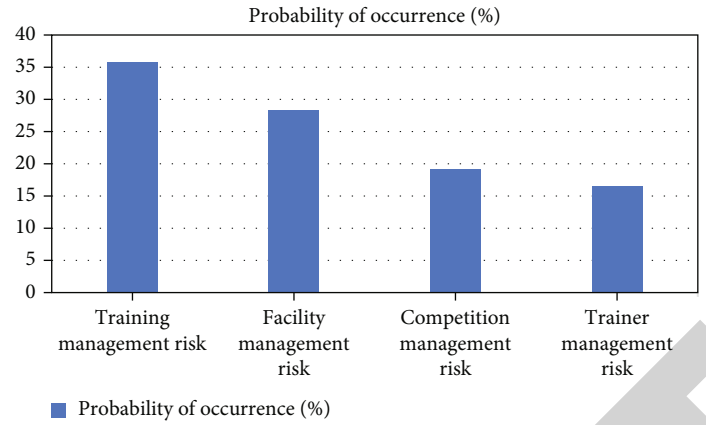

Figure 2: Probability of occurrence of several common sports training risks.

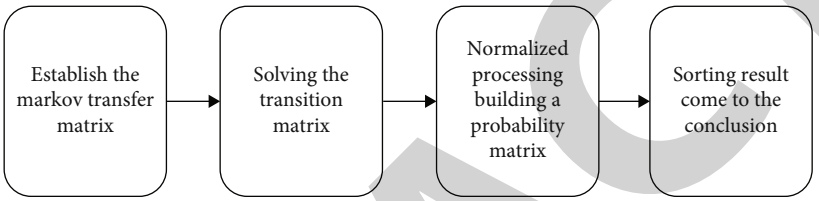

Figure 3: Steps to predict sports training risks using the Markov model.

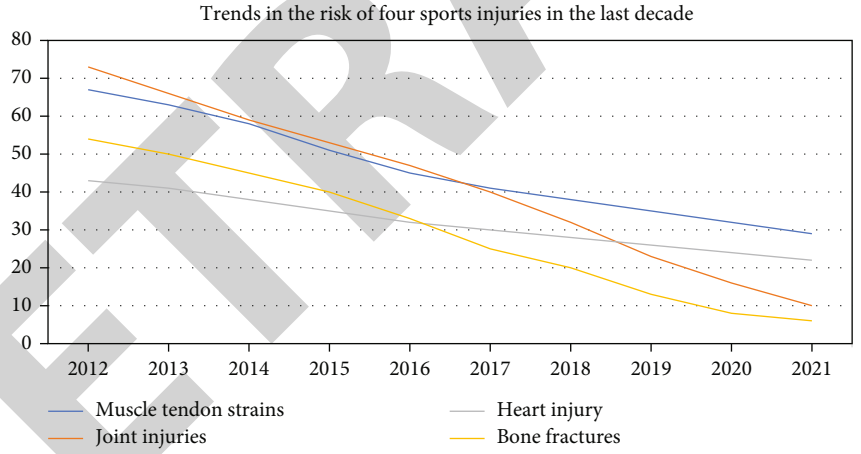

Figure 4: The trend of the change of risk caused by four kinds of sports injuries in the past ten years.

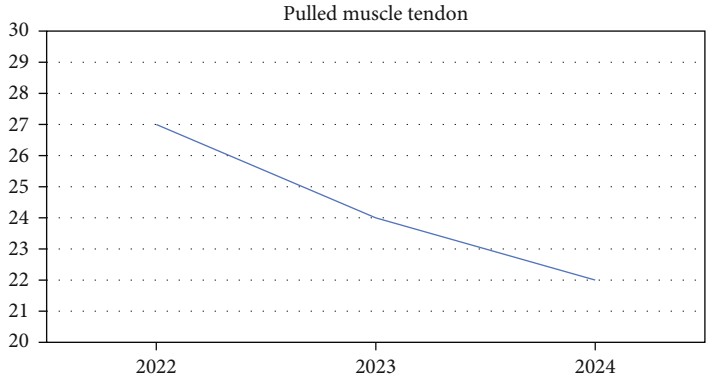

Figure 5: Prediction curve of the risk of muscle tendon strain in the next three years.

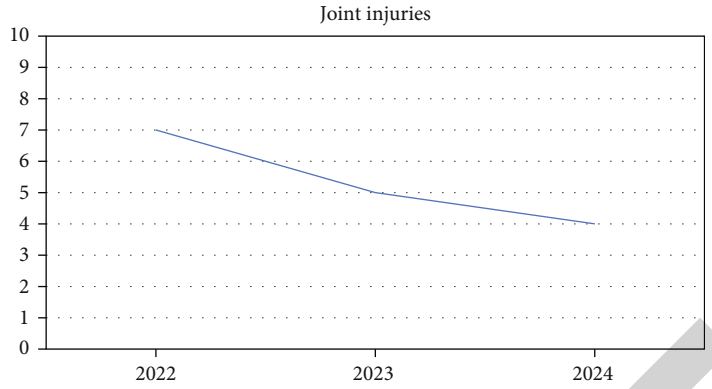

Figure 6: Predicted risk curve for joint injuries over the next three years.

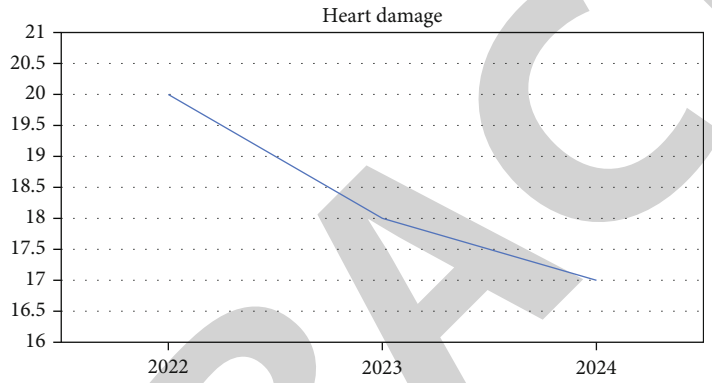

Figure 7: Predicted risk of heart injury over the next three years.

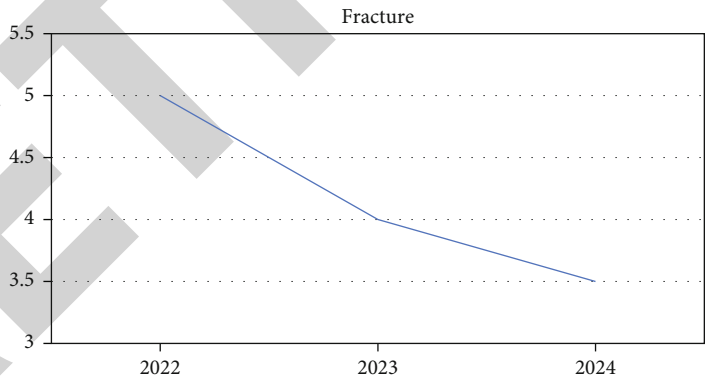

Figure 8: Fracture risk prediction curve for the next three years.

more people choose to train with the coach, which significantly reduces the risk caused by external factors

(2) With the development of science, the knowledge of sports training has become more abundant and the technology has become more mature; people pay more and more attention to the maintenance problems before and after sports training, which is why the risk of muscle tendon strain and heart injury is gradually decreasing. For example, warming up before formal training, stretching after training, and proper diet during sports training have greatly reduced the damage caused to the internal body by improper sports training

Based on the above theory and analysis, the following suggestions and plans are made for the control of sports training risks.

First, we should focus on the management of hardware facilities and improve the infrastructure of sports training. Hardware facilities are the material basis for carrying out sports training activities; therefore, when organizing sports training, it is necessary to check the degree of perfection of

sports training facilities, whether there is a greater risk of injury to the human body, and in the design of new sports training equipment, it is also necessary to consider the human body structure, sports training methods and methods, endurance, and other aspects and strive to design both in line with human mechanics but also to ensure the long-term use of training equipment.

Second, to focus on the repair of sports injuries, the need for timely treatment and therapy is necessary. Generally speaking, the main recovery measures used only after sports injuries are four: Chinese medicine treatment, sports therapy, physical therapy, and massage therapy. Chinese medicine has significant efficacy and economic price, can cure the symptoms and other characteristics, and has a long history in China; in the specific treatment process, according to the specific condition of the sports injury site, the degree of injury reasonably selected Chinese medicine preparations, which do a good job of pain treatment and anti-inflammatory treatment, to speed up the trainer sports injury recovery speed, to help it return to normal status faster; sports therapy is mainly for the trainer rehabilitation training; when the trainer sports injury occurs, the trainer sports injury recovery measures. When the trainer experiences sports injury, the use of rehabilitation training can maintain its normal cardiovascular and cerebrovascular function and prevent muscle atrophy, to avoid adverse changes in the joints; physical therapy is a common medical treatment method, mainly including cold therapy and heat therapy; cold therapy can quickly reduce the current temperature of the local skin, contract the local skin capillaries, effectively control the amount of bleeding, and reduce the sensitivity of the central nervous system, thus playing a pain relief, hemostasis, and anti-inflammatory effects; more commonly used is thermal therapy, such as repairing sports injury parts of the tissue using an infrared irradiation method to help trainers recover from sports injuries; the massage recovery method for the treatment of soft tissue injuries has significant efficacy, the recovery speed of the injured parts is faster, this method has no side effects on the human body and can accelerate the recovery speed of sports injury tissue, but want to use the massage recovery method correctly, must have a systematic understanding of the body's physiological structure, familiar with different acupuncture points, need further study.

Not only that but also to strengthen the rules and regulations of sports and athletics. In athletic competitions, everyone will play their best sports to fight, the probability of risk becomes higher. Therefore, in sports competition, managers must strengthen the rules management of the competition, uphold the principle of fairness, justice and openness, promote the orderly development of sports competition, for violations of fairness must be severely punished but also to strengthen the sportsmanship of participants, control the order of sports competition.

Finally, when trainers train, coaches must pay attention to the issue of mental health. A big role of sports training is to promote the development of people's psychological health, so in the process of sports training, great attention must be paid to the psychological problems of trainers, especially if trainers vent through training, more correct guidance, so as not to over-train because of psychological problems, causing harm to the body, to help trainers properly deal with mental health problems, to exclude negative emotional pressure, to maintain positive mindset.

5. Conclusion

The main purpose of this paper is to analyze the risks generated by athletic training since the last decade and predict the risks of athletic training in the next three years by building a Markov model and also to make some recommendations for the risks of athletic training. The main work carried out is shown below.

(1) The importance of studying sports training and the types of common risks in sports training are introduced

(2) The concept, meaning, and establishment method of the Markov model were introduced, and the development history and application scenarios of the Markov model were investigated through literature

(3) A Markov model for prediction of sports training risks was established, and the frequency of sports training risks in the next three years was predicted based on the unit year, and it was found that with the progress and development of technology, the risks generated by sports training would be reduced year by year and the reduction would become larger

(4) Suggestions are made for the possible risks arising from sports training, and it is hoped that the increasing level of awareness and improving sports knowledge will lead to better risk avoidance

In addition, the Markov model is a very practical probabilistic statistical model with strong and high application value in speech recognition, risk prediction, accident handling, engineering design, etc. In the future, it will definitely be more widely used in various different fields.

In the future, with the continuous development of science and technology, sports training will certainly be more perfect and humanized, and with the introduction of artificial intelligence and automatic control, sports training will definitely be more safe and reliable, and as long as everyone insists on reasonable physical training, the body will definitely be healthier.

The Markov model-based sports training risk prediction model proposed in this paper has some imperfections and needs further improvement.

First, the analysis is not comprehensive enough, only for the most common training risks in sports training among sports injuries, but in fact, there are many risks in sports training, and they affect each other, and because of this, it brings more difficulties to the establishment of the model and also affects the accuracy.

Secondly, in making predictions only through data analysis modeling predictions, and the future with the

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Research Article

Construction of Inflation Forecasting Model Based on Ensemble Empirical Mode Decomposition and Bayesian Model

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The high explanatory power of the first-order lag term of inflation in the inflation explanatory factor is that, on the one hand, the calculation of annual inflation indicators makes the inflation values of adjacent months cover the high correlation caused by the common price increase, and on the other hand, it also shows that people's perception of inflation is high. Some adaptability is expected. Although there are many Bayesian models available, due to the limitation of high-dimensional characteristics of the economy, most of the current inflation forecasting researches focus on a variety of generalized naive Bayesian models. By summarizing and analyzing the structural characteristics, learning methods, and classification principles of different Bayesian models, this paper finds out the important factors that affect the performance of the models and provides a theoretical basis for further improving the performance of Bayesian inflation forecasting. In this paper, the empirical mode decomposition method is introduced into inflation forecasting, and EEMD has obvious advantages in dealing with nonstationary and nonlinear time series and can decompose the signal according to the time scale characteristics of the data itself. Decompose the original time series step by step to generate eigenmode functions with different time scales. It is divided into high-frequency sequence and low-frequency sequence. Use rolling method and iterative method to construct subsamples for the sample data in this sample interval, forecast the inflation rate of each subsample interval in the next 12 months, and then compare the predicted value with the actual value to obtain a certain constructive conclusion. The predicted value is relatively close to the real value, which has theoretical and practical significance, and the predicted results obtained have no obvious regularity, but the root mean square error can be kept within 60%. By comparing the predicted value and the actual value, it can be seen that the prediction effect of the EEMD model is better.

1. Introduction

This paper evaluates the fit of conditional forecast densities based on Bayesian models to commonly used assumptions of normality to assess the feasibility and accuracy of different output growth and inflation forecasting models. Unlike point forecasting, which is limited to "deterministic equivalence," density forecasting estimates the future conditional probability density function of economic variables based on existing information, which fully describes the uncertainty associated with forecasting. Therefore, based on the fact that decision makers often have asymmetric loss functions, research on density forecasting that can characterize forecast-related uncertainty is particularly important [1]. Governments all over the world regard price stabilization as one of their macrocontrol objectives. Price stabilization can provide policymakers with a stable expected environment and play a guiding role in resource allocation. As the maker and executor of monetary policy, in order to achieve the goal of stabilizing prices, the central bank must enhance the forward-looking of monetary policy, make reasonable judgments about future inflation, and take appropriate measures to bring inflation back to the target range and prevent price fluctuations, to prevent huge fluctuations in the economy [2]. The correct direction of the central bank's regulation depends on the accurate prediction of future inflation,

and economists must think deeply and discuss how to model and predict inflation. This is not only because inflation and inflation forecasting are monetary economics and market. The main concern is to establish an inflation forecasting model, which can accurately predict the time and level of future inflation, which can provide reference for policymakers to regulate inflation.

Inflation prediction refers to the process of dividing the economy into different clusters according to the differences in the characteristics of the economy. The purpose is to make the distance between economies in the same cluster as small as possible and the distance between economies in different clusters as large as possible [3]. Inflation is very important in the development of macro control policies, and there is a delay in the influence of monetary policy on inflation, so it is very important to determine the price of prices in advance, and many national governments are estimated by the price level as an intermediary target of monetary policy [4]. In contrast to economic classification, samples in inflation forecasting have no class labels and need to be automatically determined by a clustering algorithm. The uncertainty of the model and parameters and the comprehensive and effective use of information are the main factors that affect the prediction accuracy of macro variables. This paper uses the Bayesian model averaging method to model and predict out-of-sample inflation, synthesizes information from alternative models and variables to control model uncertainty, and effectively utilizes abundant macro data information. For the in-sample fitting of inflation, the Bayesian model averaging (BMA) method is better than the single model; for out-of-sample forecasting, under the RMSE criterion, the Bayesian model averaging method is better than the more popular AR models, main component analysis model, Phillips curve model, interest rate term structure model, single optimal model, and five-variable model [5]. Not only that inflation and inflation forecasting are the main concerns of monetary economics and the market, but also that the establishment of an inflation forecasting model can accurately predict the time and level of future inflation, which can provide a reference for policymakers to regulate inflation.

Therefore, the inflation rate can be kept in a moderate range to promote the rapid, stable, and healthy development of the economy. There is not only one source of price rises, and it is affected by many factors. This paper summarizes the causes of inflation into the following three aspects: first, it is explained from the perspective of the quantity theory of money, highlighting the important influence of money on inflation; second, it is explained from the perspective of supply and demand; third, explain the causes of inflation from the perspective of changes in economic structural factors. Using EEMD can automatically track changes in the data and continuously adjust estimates of short-term trends contained in the series. The premise of using EEMD is that the trend of the time series is stable and regular, so it can accurately predict the future situation. The most recent data can better reflect the regularity of the time series trend than the old data, so a larger weight should be set on the recent data. The short-term forecasting effect of this forecasting method is better. This method has more advantages than the simple average method and the moving average method. It not only considers the past data but also assigns different weights according to the time distance of the data, and the prediction accuracy is very high [6]. In the field of macroeconomics, people pay more attention to long-term trends and cyclical trends in time series. Therefore, decomposing the trend elements and cyclic elements of the time series to obtain useful information is a very important content in time series analysis [6, 7].

The innovation of this paper: the innovation of this paper is mainly in the way of comparison, according to the forecast results of inflation to analyze and compare the pros and cons of the model's predictive ability. In this paper, the sample time period is divided into 12 small sample intervals according to the rolling method and iterative method, and the EEMD model is used for inflation prediction analysis for each small sample interval. In the small sample interval obtained by the rolling method, the number of samples contained in each sample interval is the same, but the historical periods at the beginning and end of each small sample interval are different. In the small sample interval obtained by the iterative method, the initial period of the historical period of each sample interval is the same, but the end period is different, so the number of samples in each small sample interval is different. Such a sample division allows for a more comprehensive comparison of inflation forecasting models.

Chapter arrangement of this paper: Chapter 1 introduces the research on EEMD model and inflation forecasting; Chapter 2 introduces the development and basic theory of ensemble empirical mode decomposition and tests the IMF unit stationarity of EEMD model. The third chapter conducts data analysis experiments on inflation index based on the EEMD model; the fourth chapter summarizes the full text.

2. Related Work

As a new time series analysis tool, the empirical mode decomposition method has been applied in many fields and achieved good results. Starting from the related research and analysis of the empirical mode decomposition method, this paper expounds the research status of the EMD method from the perspective of theory and application.

Inflation is a time-honored topic in economics. Inflation has become a concomitant of human social and economic activities since money was used as a general equivalent for the exchange of goods [8]. Kim studied the performance of stocks in different industries at different stages of the economic cycle and believed that the existence of the economic cycle is conducive to the implementation of industry rotation investment strategies [9]. Franses studied the correlation between the financial and economic cycles in 44 countries from 1960 to 2010. The results show that there is a certain correlation between the economic and financial cycles at different stages, especially when the economy is in recession. The conditions caused by the bursting of real estate and stock price bubbles were longer in duration and farther-reaching than other recessions [10]. Lanne and

Luoto analyze the relationship between economic operation, stock market fluctuation cycle, and industrial development and believe that the development of the industry determines the cycle of economic operation, and the adjustment of the economic cycle is transmitted to the stock market through changes in related industries, thereby affecting the return on financial assets. The stock market fluctuates with the change of the economic trajectory [11]. Espinosatorres et al. use the DCC method to study the relationship between the stock market cycle and the macroeconomic cycle. Through empirical research on the data from 1996.01 to 2010.12, it is found that the volatility of the stock market has a dynamic and time-varying correlation with economic and financial cycles. It is positively correlated during the investigation period. In the economic trajectory of different stages, the correlation coefficient between the cycle of the stock market and the cycle of finance and the real economy is different, reflecting the characteristics of bull and bear markets in different stages. In addition, they also found that the level of dynamic correlation between the up and down cycle of the stock market and the economic cycle is gradually strengthened [12]. Using the stock market and macroeconomic variables from 1999 to 2009, Yang and Guo establish a simultaneous equation model for the return of stock index and macroeconomic variables and empirically analyze the relationship between the return of the stock market and the fluctuation of macroeconomics. The results show that the stock investment return can be used as a leading indicator in the recovery stage of the economic cycle and the prosperity and middle stages, that is, the upward stage of the economic cycle has a certain correlation with stock returns [13]. Kurihara uses the causality test method to empirically test the causal relationship between money supply, economic growth, wage costs, and inflation [14]. McGurk uses the causality test method to analyze the relationship between inflation and economic growth. It is concluded that inflation hinders economic growth. Because they did not test the stationarity of inflation macroeconomic data, they directly used nonstationary time series data to model and analyze, so the conclusions they got were not scientific enough. In recent years, a very small number of scholars have used modern econometrics for empirical research on inflation [15]. Gilenko and Smelkov examined the data of 110 countries and came to the conclusion that the inflation rate and the money supply are related to each other. Changes have a very strong correlation, the correlation coefficient is between and almost close to, and in the long run, the increase in the money supply will eventually lead to the same degree of inflation [16]. Zhu and Peng examined the effects of deficit, financial system variables such as the degree of central bank independence, the degree of financial market development, and the growth rate of money supply on inflation. Countries: the inflation effect of deficit is more significant. It proves that inflation in Slovakia is mainly affected by foreign prices, exchange rates, and wages. The impact of money supply on inflation is direct and rapid, and the impact of interest rates on inflation is moderate but gradual. Scholars have conducted theoretical discussions on inflation [17]. Wang et al. made an in-depth theoretical analysis of the inflation problem and formed the first monograph to systematically analyze the inflation problem in the socialist economy [18]. Beckers started from the actual situation, and while absorbing the foreign inflation research results, he deeply discussed and analyzed the inflation problem. Generality and specificity of inflation: they made a detailed discussion on the causes of inflation, the relationship between economic system and inflation, and governance and achieved certain research results. However, most of these literatures describe it from a qualitative perspective, and few systematically use quantitative analysis [19]. Nyonit used the method of combining econometrics and input-output analysis, extended linear expenditure system to analyze the total amount and structure of inflation, and established a quantitative analysis model of inflation [20]. In the study of Qiao et al., the Granger causality test method for the driving factors of inflation is analyzed, and a regression equation is established, and it is concluded that currency circulation, fixed asset investment, consumption, wages, and savings all play a role in promoting inflation [21]. Castillo et al. uses multiple regression analysis methods to establish a measurement of economic model, and the system investigates the impact of major economic factors on inflation [22].

Since the relationship between inflation and the economy is quite complex, the multivariate model is more reasonable than the bivariate model. In the study of causality, a cointegration test should be carried out. Once a cointegration relationship between variables is found, the cointegration relationship should be calculated as the form of error correction term is incorporated into the model; otherwise, the model will be imperfect. Therefore, it is very urgent to use the ensemble empirical model to systematically examine the main economic factors that affect inflation, to explain their influence on inflation, and to accurately analyze the causes of inflation.

3. Relevant Theoretical Basis

3.1. Bayesian Model. Inflation forecasting is a complex process, including major steps such as economic preprocessing, economic representation, feature selection, classification model design, and performance evaluation. The core of which is the design of classification model, which has the greatest impact on inflation forecasting performance, followed by feature selection. After determining the classification idea and implementation method of the component model in the ensemble, let us analyze how to create more component models and add them to the classifier ensemble, so as to use the complementarity and difference between members to improve the ensemble's ability to understand different languages. Economic adaptability: most of the traditional classification models are only for specific languages and require word segmentation preprocessing. The main reason for the confusion of the EMD algorithm pattern is the discontinuity of the sequence. At the same time, the discontinuity also causes some IMF components to lose their specific physical meaning. First, the intermittent test relies on subjective judgment to a certain extent, and the determination of the intermittent point depends on the

experimenter, thus affecting the results of EMD decomposition. In this paper, we apply the classifier ensemble framework to the Bayesian model and propose a language-independent Bayesian ensemble classification model. Each classifier in the model is composed of a combination of N-Gram and a naive Bayesian model. The local conditional probability constraints provided by the order N-Gram model generate differential component models. Based on this, we apply it to the classifier ensemble framework and propose a new ensemble mode and adaptive ensemble method, which utilizes the performance differences of the models on different economic sets to realize the combination of the classifier selection method and the classifier fusion method. Organically combined judgments made on the significance of parameters under the assumption that a single model is correct are almost always wrong under the method. Therefore, the explanatory power of all explanatory variables to inflation cannot be judged by the statistics calculated by a single model.

3.2. EEMD Decomposition Theory. Although the EMD decomposition method can adaptively decompose the signal into different frequencies, if the time series does not fully conform to the definition of white noise, some frequency scale components may be found, resulting in mode confusion, that is, one IMF component contains other different A signal sequence of frequencies or a sequence of frequencies appearing in multiple IMF components. Since most of the data in the real world contains noise, the pattern confusion cannot be completely eliminated in the EMD algorithm, which is also a defect of the EMD algorithm. Subjective measures are feasible only when the order is clear and the specific time scale is; otherwise, intermittent testing has limited effect. Therefore, in order to overcome the above drawbacks, an ensemble empirical mode decomposition method, EEMD, is proposed. The decomposition principle of EEMD is to use the uniform frequency distribution characteristics of white noise sequences. When white noise is added to the time series, the distribution characteristics of the extreme points of the low-frequency components of the sequence will change, so as to ensure that the average value of the upper and lower envelopes of the sequence can be accurately obtained, and the average value of multiple decompositions will be used as the actual IMF sequence. This approach also avoids the shortcomings of prior judgment in intermittent testing [23]. The basic idea of empirical mode decomposition is actually to convert a signal with irregular frequency into the form of multiple single-frequency waves plus aftermath. The essence of the EMD method is to obtain intrinsic fluctuation patterns through the characteristic time scale of the data and then decompose the data. This decomposition process can also be vividly called a "screening" process, and it can be demonstrated that the EMD decomposition is complete and orthogonal.

Since the added white noise obeys a uniform distribution in the time-frequency range, although different white noises are added in each uncorrelated experiment, since the decomposition step finally obtains the IMF component by averaging multiple experiments, the final experiment noise will be removed when averaging is obtained. It should be noted that the additional noise signal is not unlimited, and the amplitude value of the noise signal should be fixed, so that various signal sequences are classified into the corresponding IMFs, so that the average value of the obtained data is closer to reality. The adaptive white noise method should satisfy the following equation:

$$0 < \alpha < \frac{\varepsilon}{2}. \tag{1}$$

The ε is the ratio of the amplitude standard deviation of the highest frequency IMF after the sequence EMD decomposes. Through the endogenous variables to construct the lag value of all endometric variables of the system, it is estimated that the dynamic relationship between endogenous variables is to achieve the effect of "letting the data yourself." EEMD model expression is shown in (2).

$$X_t = \alpha_1 \sum \Phi_{1t} X_{t-p} + \sum H_{1t} Y_{t-p} + \varepsilon_{1t}, \tag{2}$$

$$Y_t = \alpha_1 \sum \Phi_{2t} Y_{t-p} + \sum H_{2t} Y_{t-p} + \varepsilon_{2t}. \tag{3}$$

Before the parameter estimation of the EEMD model, the appropriate lag order must be determined. When the determined value is determined, on the one hand, it is desirable to eliminate the autocorrelation in the error term, so that the dynamic characteristics of the system are completely reflected, but if excessive, it will result in excessive parameters that need to be estimated and reduce the freedom of the model, which affects the validity of parameter estimation. When determining the lag step, the method that is often used includes the LR test, AIC information guidelines, and SC information guidelines.

The LR test method sets the original hypothesis to be in the lag of rear step $p = i$, the coefficient matrix element is 0, then the x^2 statistic LR is constructed from the maximum hysteresis step, and the critical value of the statistic and 95% confidence is compared. When $x^2_{0.05} > 0$, reject the original hypothesis, indicating that the lag scale can significantly increase greatly; otherwise, it will accept the original hypothesis. Decrease a lag number each time until the rejection is the original hypothesis. SCI is also known as BIC Guidelines; AIC Guidelines and BIC Guidelines are as follows:

$$\mathrm{AIC} = \frac{-2l}{T} + \frac{2n}{T}, \tag{4}$$

$$\mathrm{SC} = \frac{-2l}{T} + \frac{n \ln T}{T}. \tag{5}$$

In the EEMD model, the time series in the equation must be smooth, so the stability of the variable is required to be tested when modeling. The most common method of testing time series is the unit root test, and the unit root inspection includes the ADF method as shown in the following equation:

$$\Delta X_t = \delta X_{t-1} + \sum_{i=1}^{m} \beta_i \Delta X_{t-i} + \varepsilon_t. \tag{6}$$

Suppose zero assumptions in the test $\delta = 0$, that is, one unit root, 1. Check the statistical to measure whether to distribute from the ADF, when the test is rejected, a false holiday H. The original time sequence does not exist in unit roots, it is a smooth sequence, and the test is stopped; otherwise, the model is continued to be 1.

This chapter uses EEMD to decompose fluctuations in inflation different frequency domains. EEMD decomposition is performed on inflation, and the IMF components of different frequency domains are obtained, and the angle of three indicators of Pearson correlation coefficients is evaluated by the average cycle and the point of variance. The IMF is divided into high frequency, low frequency, and trend components according to the frequency domain, and its economic significance is explained. Further, for the low-frequency and high-frequency components of inflation, an appropriate model is established to analyze its influencing factors. The specific idea is shown in Figure 1 below.

Inflation as a macroeconomic phenomenon, and it reflects the general price level rather than a single commodity price change, thereby producing how to measure inflation. To this end, it is necessary to solve the following two questions, how is the price index of general price levels from individual commodities and services? Which price index can be more appropriately measuring inflation? From the statistical point of view, the main principle of choosing the price index is in addition to accuracy, and there is easy understanding, simple, sensitivity, and easy access to the right. Due to the complication of the "ideal index," it is more difficult to obtain the current weight data required to obtain the resort price index calculation, and therefore, widely used is a lass price index and its modified weighted average index. In recent years, many economists have proposed some new methods such as social monetary circulation measurement methods, monetary purchase force measurement, and currency supply and demand measurement, but they cannot accurately calculate money supply and demand. Gaps and currency flow speed: to objectively reflect the changes of inflation, the indicators selected should meet three conditions. First, it is necessary to reflect the reality of the market economy, and in line with the international general practical practice, it is conducive to the international exchange and comparison, and three is to have operation. Sexuality and timeliness can meet the needs of short-term macroeconomic regulation goals. Based on the above three points, many economists believe that choosing as an inflation metric indicator is relatively appropriate.

Inflation caused by changes in aggregate demand is called demand-induced price increases, and aggregate demand is greater than aggregate supply, resulting in a continuous and significant increase in prices. Fluctuations in government spending, investment, and net exports all have an impact on aggregate demand, driving output growth beyond potential productive capacity. Demand-pull inflation occurs when aggregate demand grows faster than the economy's potential productive capacity. Prices will rise so that aggregate demand and aggregate supply are in balance. If the quantity of money increases, the aggregate demand will increase but will not lead to an increase in prices; when the economy reaches a state of full employment, if the quantity of money increases, the aggregate social demand will increase, which will lead to an increase in prices.

3.3. IMF Test Results. The EEMD method has been widely used in various fields for its excellent performance in solving model uncertainty problems. The typical practice of people analyzing data is to select the optimal model among many models and then make statistical inferences under the optimal model. Choosing the optimal model means abandoning the "suboptimal" model. The problem of information loss caused by abandoning the "suboptimal" model is called the model uncertainty problem, which makes the statistical inferences made under the optimal model credible. The reduction of its degree cannot be ignored.

There are many factors that affect inflation, but because many factors overlap each other, and in order to reflect the main economic factors that affect inflation, it is necessary to select several representative ones from many factors. Taking all factors into consideration, this paper selects the index, broad money, the total investment in fixed assets of the whole society, the average salary of employees, and foreign exchange reserves as the main variables that affect inflation, and many other factors that affect inflation will be treated as random factors. The data are derived from the ten-year change of a certain database. According to the test principle, the software is used to test the stationarity of each logarithmic value and the difference series, respectively. The Akaike information criterion is used to determine the lag order in the test process, and the results are shown in Figure 2.

The test results in Figure 2 show that in the sample period, using the unit root test method, the EEMD series cannot reject the unit root process at the 10% significance level, that is, they are all nonstationary time series; in its first-order difference series, the unit root process can be rejected at the 10% significance level, the unit root process can be rejected at the 5% significance level, and the unit root process cannot be rejected at the 10% significance level. The series is stationary at the 1% significance level, while A can reject the unit root process at the 5% significance level.

When testing each variable IMF, the modified lag window uses the Bartleet window. The test results are shown in Figure 3.

The test results in Figure 3 show that in the sample period, using the IMF unit root test method, the sequence cannot reject the unit root process at the 10% significance level, that is, it is a nonstationary time series; in its first-order difference sequence, the unit root process cannot be rejected even at the 10% significance level, the unit root process can only be rejected at the 10% significance level, and the sequence can reject the unit root process at the 5% significance level: in its second-order difference, the series is stationary at the 1% significance level, while the unit root process can be rejected at the 5% significance level.

4. Construction of Inflation Forecasting Model

4.1. Data Indicator Processing. EEMD is a sequence generated by displaying a certain parameter value in historical order. The

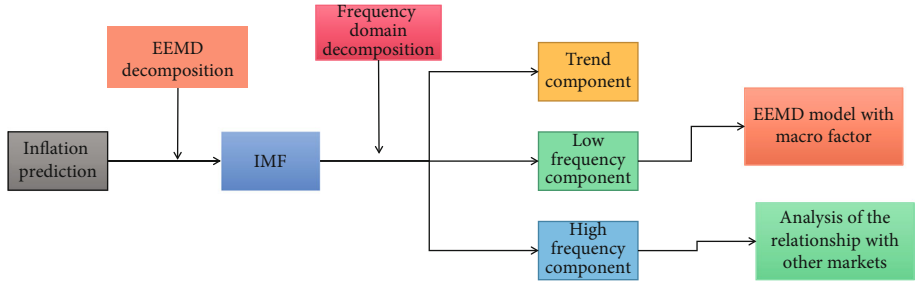

Figure 1: EEMD decomposition of inflation.

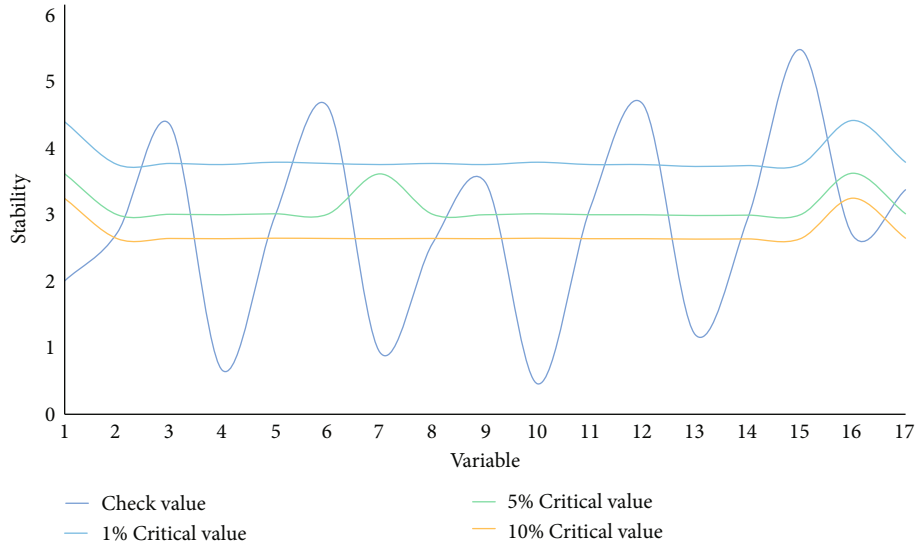

Figure 2: EEMD unit stationarity test.

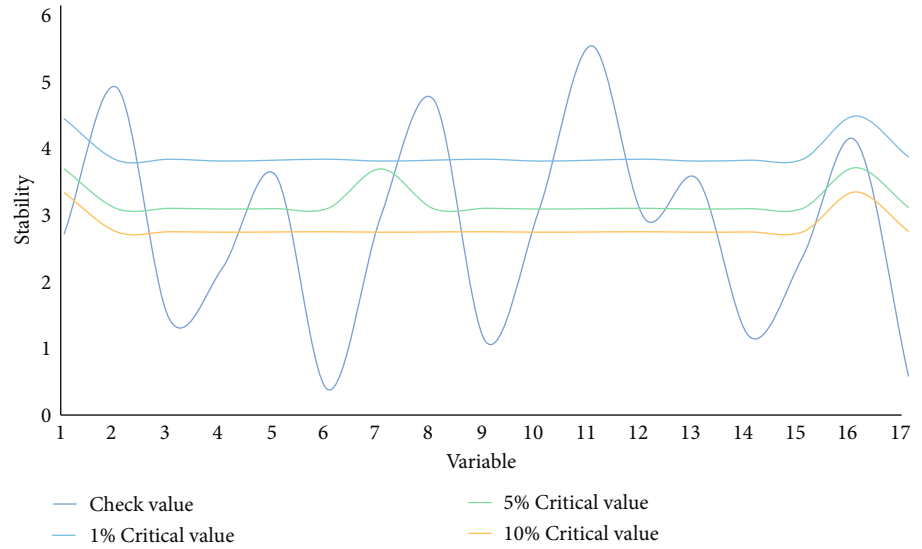

Figure 3: IMF unit stationarity test.

time series estimation method refers to constructing and studying the series and then inferring or expanding the evolution process and trend of the series to estimate the level that can be reached in the next time period or the next few years.

Exponential smoothing is usually used for time series with no significant trend changes or time series with long-term trends but frequently changing short-term trends. EEMD automatically tracks changes in the data and continually adjusts its

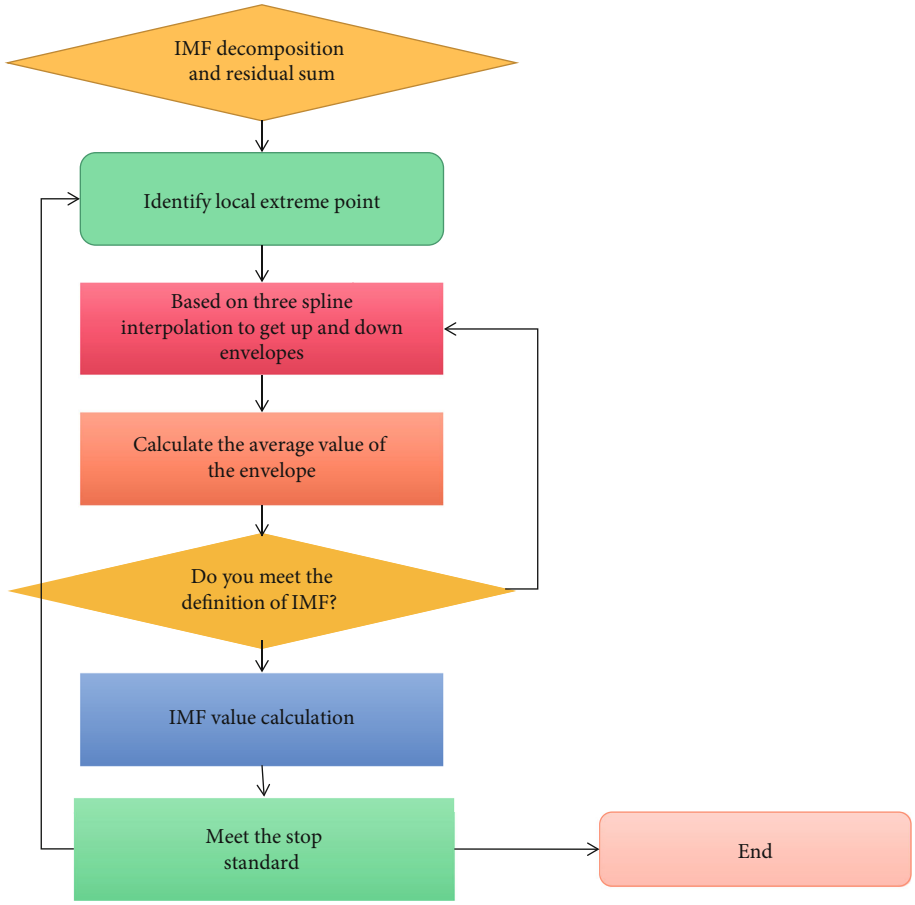

Figure 4: Data indicator processing flow.

approach to estimating short-term trends contained in the series. The data flow is shown in Figure 4.

The premise of using EEMD is that the trend of time series is stable and regular, so it can accurately predict the future situation. The most recent data can better reflect the regularity of the time series trend than the old data, so a larger weight should be set on the recent data. This method has more advantages than the simple average method and the moving average method. It not only considers the past data but also assigns different weights according to the time distance of the data, and the prediction accuracy is very high.

4.2. Stationarity Test. The EEMD stability is the basis for building the model. If the EEMD is unstable, the model must be built to meet the requirements of stationarity through differential operation. Therefore, we must first check the stationarity of the series. This paper adopts the method of combining the autocorrelation function test method and the unit root test method to test the stationarity of the time series. Since we selected monthly data, we chose a lag of 12. The sequence available through software operation is shown in Figure 5.

From the autocorrelation function diagram of the time series, it can be seen that the histogram does not change to 0 quickly with the increase of the lag order, and the following conclusions can be drawn: EEMD is not a stationary series, and the model construction cannot be started. If the original sequence is not stable, but the sequence obtained after the difference operation of different orders is stable, so do a difference operation on the sequence and check the autocorrelation function after the difference operation again; the result is shown in Figure 6.

From the ADF test results of the time series in Figure 6, it can be concluded that in the null hypothesis, the time series has a unit root, that is, the series is not stationary. The significance test result of its unit root is 0, and the absolute value of AC is greater than the absolute value of 1%, 5%, and 10% level, indicating that the null hypothesis is rejected at 1%, 5%, and 10%. Therefore, the time series is a stationary series, and an EEMD model can be established.

4.3. EEMD Model Prediction. The above has verified that the model EEMD is reasonable, so it can be used to estimate short-term inflation. Since we want to predict the inflation level of a certain place for one year, we must first expand the sample interval, use the EEMD function to obtain the prediction result, and obtain the comparative analysis of the predicted value and the actual value at the same time as shown in Figure 7.

By comparing the predicted value and the actual value, it can be seen that the prediction effect of the EEMD model is

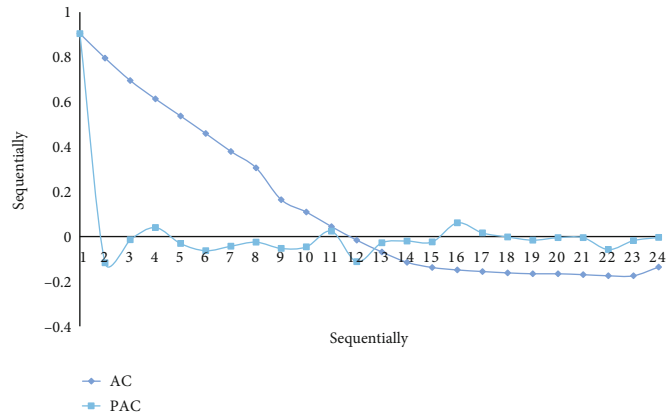

Figure 5: Time series autocorrelation function.

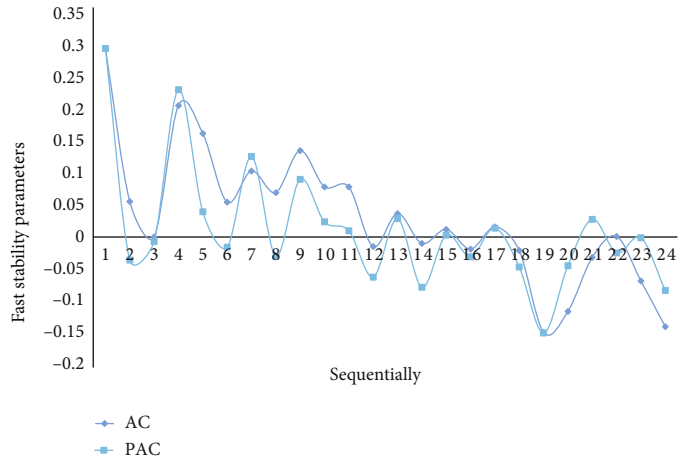

Figure 6: Autocorrelation function after the first-order difference of the sequence.

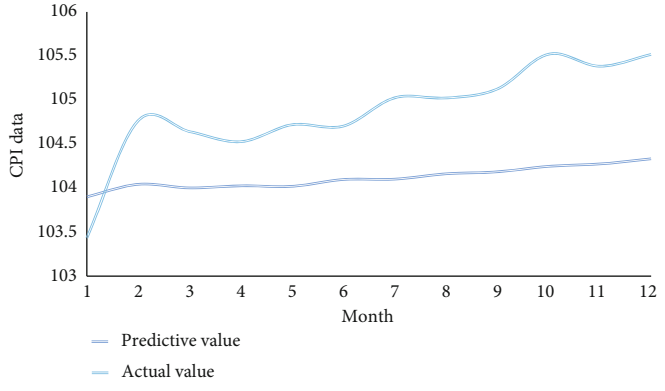

Figure 7: Comparison of prediction results.

better, and the predicted value is relatively close to the actual value, which has theoretical and practical significance.

4.4. Model Comparison. According to the steps of sample interval modeling, models are established for different time sample intervals. In the real model construction, it is generally desirable that the lag period is very large, so that the fluctuation of the model can be fully represented. However, if the lag period is relatively long, the variables that need to be estimated in the model will increase, and the degrees of freedom will decrease. Therefore, it is necessary to find a balance between hysteresis and degrees of

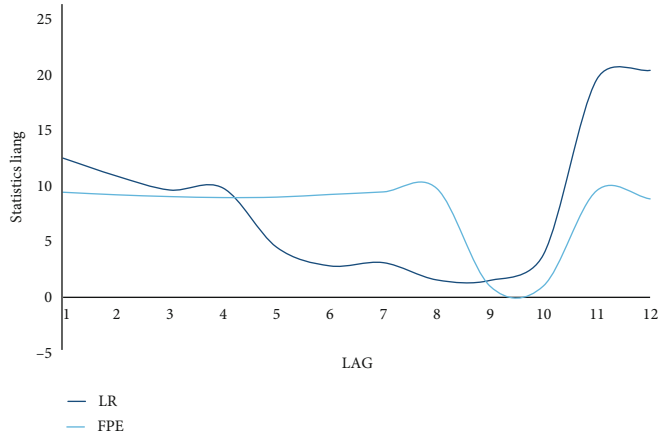

Figure 8: Judgment result of lag order.

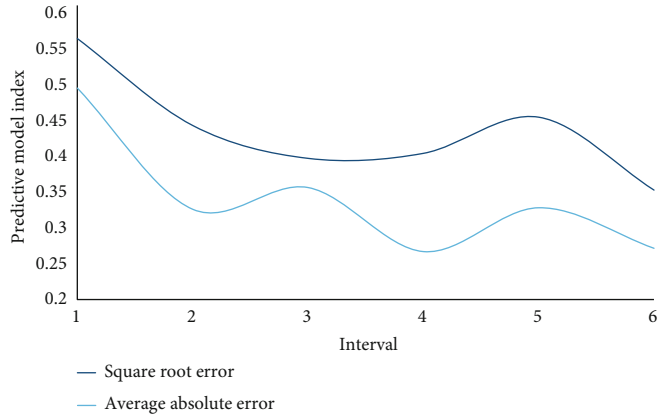

Figure 9: Prediction model index comparison chart.

freedom. In the EEMD model, the LR test statistic, the final prediction error FPE information criterion, and the results are provided, and the maximum lag order of the model can be obtained. Since we select monthly data, the maximum lag order of the input model to be investigated is 12, and the comparison results of the actual inflation value and the predicted value in each sample interval are shown in Figures 8 and 9.

It can be seen from Figures 8 and 9 that the prediction results obtained by EEMD prediction for sample intervals of the same length and different time starting points have no obvious regularity, but the root mean square error can be kept within 60%. The prediction results obtained by EEMD prediction are better as the length of the sample interval increases.

5. Conclusions

Inflation is the most important research topic in monetary economics. It is necessary for economists to study inflation in depth. It is also an important economic indicator closely related to people's livelihood. It is related to the vital interests of the people. This paper uses the Bayesian model method EEMD model to study inflation for forecasting. The study finds that the first-order lag of inflation, the growth rate of industrial added value, and currency can significantly affect the inflation rate, which can undoubtedly provide theoretical support for policy-making departments to manage inflation expectations. The advantages of Bayesian models and methods in forecasting can provide certain reference for decision-making departments. In order to take advantage of the theoretical advantages of Bayesian model method, improve the accuracy of out-of-sample inflation forecast, and reduce the forecast error, it is necessary to synthesize more complex models such as nonlinear models in future research. The uncertainty of the model and parameters and the comprehensive and effective use of information are the main factors that affect the prediction accuracy of macro variables. Use the EEMD model method to model and forecast out-of-sample inflation, integrate information from alternative models and variables to control model uncertainty, and effectively utilize abundant macro data information. The sample interval it targets is January to December, which is the longest sample interval obtained by the iterative method. While proving the previous conclusion, it can also be seen that the LR value has a large lag order, which means that inflation has a long lag period. This echoes the lag of monetary policy, and it will take a long period

of time for macroeconomic policy adjustment and control to achieve the goal of adjustment in response to the current inflation situation. If the forecast accuracy of inflation can be improved and the relevant monetary policy can be formulated according to it, the current situation of monetary policy time lag can be improved. At the same time, it also helps to accurately guide the market operation and the public's expectation of inflation and achieve the ideal result of improving the effectiveness of monetary policy.

The standard for comparing the pros and cons of prediction models is relatively simple. Only the FPE of the EEMD model was compared, and other statistical-based model prediction comparison methods were not considered. Only the EEMD model including the variable LR fixed-base price index and broad money supply is aligned with the nominal effective exchange rate including the variable LR fixed-base price index and broad money supply. The number of variables involved is relatively small, and the comparison method has certain limitations.

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Research Article

Automatic Recognition Method of Fall Movement of Sports Fitness Human Body Based on Posture Data Sequence

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In order to improve the recognition accuracy of human falling actions, the impact of randomness of actions is reduced. To this end, this paper proposes an automatic recognition method for physical fitness human fall based on pose data sequence. The color camera is used to collect the fall motion images of the physical fitness personnel, and the motion image preprocessing is completed by extracting the fall motion features of the human body, tracking and adjusting the fall motion of the human body. A model of human body fall movement displacement feature extraction from posture data sequence is constructed. By tracking the displacement feature points, the automatic recognition of physical fitness human body fall movement based on posture data sequence is realized. The experimental results confirm that the proposed method can effectively obtain the details of the fall motion images of physical fitness. When the number of human falling actions reaches 500, the accuracy of action recognition is also as high as 77%, improving the recognition effect of human fall action.

1. Introduction

Physical fitness is a very important aspect of modern social life, with strong natural and social functions. As the main body of sports fitness activities, residents' views, support, and participation in decision-making on sports fitness directly affect the development of sports fitness [1, 2]. At the same time, with people's attention to healthy life, more and more people participate in physical fitness. However, because many people do not acquire enough physical fitness knowledge or do not have the guidance of professionals, accidental falls often occur [3, 4]. Fall warning in video surveillance [5] is of great significance in many occasions. For example, it can be applied to the supervision of the elderly living alone. At the same time, it can also be applied to the accidental fall of sports fitness personnel. If the video monitoring system has the ability to intelligently judge whether the monitored object falls [6], it can timely alarm relevant personnel and take remedial measures in time to reduce unnecessary loss of life and property.

A fall action recognition method is proposed based on BP neural network [7]. This method can distinguish fall from daily action by using the attitude angle and triaxial acceleration data provided by the attitude heading reference system (AHRS) fixed in the waist. Experiments on different samples of falls and daily behaviors show that this method has high recognition rate, good stability, and strong practicability. But the accuracy of this method to recognize fall action in complex environment needs to be improved. Reference [8] proposed a new method of fall recognition. Based on OpenPose deep convolution network, the key points of human posture are extracted from the image to obtain the dynamic features of human body tilt posture. But the accuracy of the key point recognition of the fall action needs to be further improved. Reference [9] presents a human fall detection method based on intelligent vision. According to the intelligent vision analysis technology, the method uses acceleration sensor to collect the data of human fall inertia and uses the acceleration sensor to establish three-axis acceleration coordinate. This method can classify fall motion accurately, but the recognition effect in complex environment needs to be improved. In [10], a VD-ZSAR method was proposed for extracting nonredundant visual features, which alleviated the relationship ambiguity caused by

redundant visual features. And by combining nonredundant visual space with semantic space, we can learn the visual-semantic joint embedding space. The fuzzy relation caused by redundant visual features can be eliminated when the fuzzy relation is applied to fall action recognition.

The currently applicable methods for human fall action recognition from pose data sequences all have the problem of low recognition accuracy. Therefore, in this research, an automatic recognition method of physical fitness human fall based on posture data sequence is designed. The method utilizes a color camera to capture the fall motion images of physical fitness personnel. On this basis, a feature extraction model of human falling action displacement in pose data sequence is constructed. By tracking the displacement feature points, the automatic recognition of physical fitness human fall based on the pose data sequence is realized, in order to further optimize the fall action recognition performance and make up for the deficiency of the randomness of the fall action on the recognition accuracy.

2. Design of Fall Recognition Method for Physical Fitness

2.1. Obtain the Image of Human Body Falling Action in Sports Fitness. The CMOS (complementary metal-oxide-semiconductor) motion sensor and the CCD (charge coupled device) motion sensor are selected by the fitness researchers to collect the fall image. The camera can simultaneously obtain the color image, depth image, and bone image of sports fitness personnel [11]. However, in the process of image acquisition, there is a problem of radial distortion [12]. Based on this, the established camera acquisition image model is shown in Figure 1.

In Figure 1, (x_0, y_0, z_0) represents the world coordinate system of color camera, and ς represents the image point of human body falling action of sports fitness personnel; (x, y, z) represents the image coordinates of human body falling action; O represents the optical center of the color camera, and there is an Z-axis coincident with the optical axis; (X_0, Y_0) represents the ideal coordinate of the human body falling action image of sports fitness personnel; (X_1, Y_1) represents the actual coordinate deviating from (X_0, Y_0); and (X, Y) represents the coordinates parallel to the o_0 and y axes at the intersection U of the z-axis and the image plane.

The fall action image model is obtained according to the color camera shown in Figure 1, in which the color image and depth image are transmitted in the form of data stream. The resolution of color image is $320 * 240$, the number of frames is 15fps, the format is Bayer format, and the color data can be encoded into rgb-64bit. The depth image acquisition process is consistent with the color image. The effective position information is 13 bits high, and the user ID information is 3 bits low. The bone image of sports fitness personnel is obtained from the depth image data, including the three-dimensional coordinates of 20 joint points. The bone map of sports fitness personnel is displayed visually [13].

In order to facilitate the recognition of fall movement of sports fitness human body, the spatial coordinate relationship between color image, depth image, and bone image of

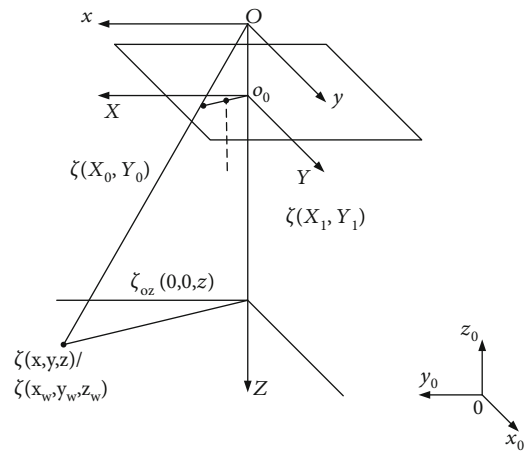

Figure 1: Image model acquired by color camera.

sports fitness personnel is analyzed. The coordinate system of color space, depth space, and skeleton space of sports fitness personnel [14] is shown in Figure 2.

Set the color space pixel coordinates as $(x(t), y(t), z(t))$, the depth space pixel coordinates as $(x_s(t), y_s(t), z_s(t))$, and the bone space pixel coordinates of sports fitness personnel as $(x_d(t), y_d(t), z_d(t))$.

The transformation formula of bone space and depth space coordinate system of sports fitness personnel is:

$$\begin{cases} x_d(t) = \dfrac{320x_s(t)}{z_s(t)\tan(a/2)} \\ y_d(t) = \dfrac{240y_s(t)}{z_s(t)\tan(b/2)} \\ z_d(t) = z_s(t)\tan a \end{cases}, \quad (1)$$

where a represents the horizontal viewing angle of the camera, with a value of 57° and b represents the vertical viewing angle of the camera, with a value of 43° [14].

The conversion formula between depth space and color space coordinate system is

$$\begin{cases} x_s(t) = \dfrac{320\Delta d}{z(t)\tan a} + x(t) \\ y_s(t) = y(t) \\ z_s(t) = z(t) \end{cases}, \quad (2)$$

where Δd represents the displacement of the color camera.

Through the above process, the fall action color image, the depth image, and the bone image of sports fitness personnel are transformed into the same coordinate system. Due to the less information content in the z direction, in order to facilitate image processing and ignore the z direction information, the resulting fall action image is $I(x, y)$, which provides image data for the automatic recognition of the following fall action.

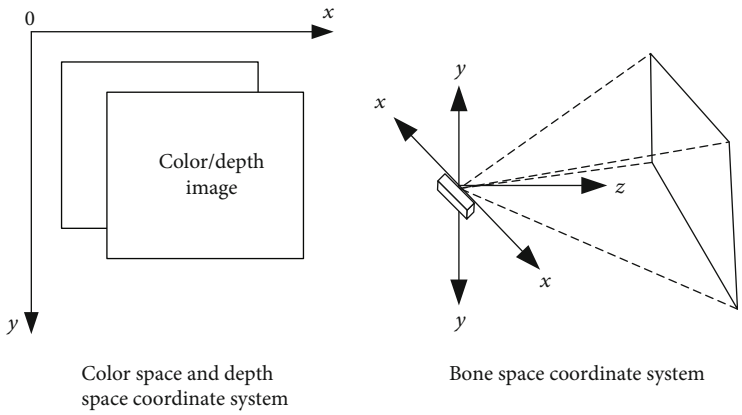

Figure 2: Schematic diagram of color space, depth space, and skeleton space coordinate system of sports fitness personnel.

3. Image Preprocessing of Human Fall

3.1. Extracting Human Fall Motion Features. The human body can be divided into five parts: trunk, left arm, right arm, left leg, and right leg. Among them, trunk is an important part to support the human body. Some joints in the waist of the human body reflect the information of their motion characteristics, while the motion information characteristics of hands and feet are shown from the joints of limbs in this part. The division results of the five parts of the human body are shown in Figure 3.

In some basic movement classification methods of sports fitness personnel, hierarchical strategy is adopted. The first level: first, the actions of the five related combination modes should be summarized into a large category. For example, only the movements of two arms are the combination of the second part and the third part, which is the result of roughly classifying the movements. The second level: reclassify the actions of the same combination mode to determine which action is the detailed classification of actions. The joint angle feature vector formed by the projection on the two-dimensional plane is verified from 17 joint angles of the human body, which is used as the first rough classification feature of human motion. According to the principle of kinematics, the features of the same combination of human body are extracted. The complete actions of a sports fitness personnel can be divided into main actions and auxiliary actions. The main action reflects the overall state of the motion mode, and the auxiliary action reflects the local state of the motion mode. Only by combining the characteristics of main and auxiliary actions can we express this action more accurately. For the body's trunk, left arm, right arm, left leg, and right leg, the limb vectors in three-dimensional space coordinates are established, respectively, which are expressed as:

$$\begin{cases} GT^{\{3\}}(t) = T^{\{3\}}(t) - G^{\{3\}}(t) \\ AJ^{\{3\}}(t) = J^{\{3\}}(t) - A^{\{3\}}(t) \\ BK^{\{3\}}(t) = K^{\{3\}}(t) - B^{\{3\}}(t) \\ EP^{\{3\}}(t) = P^{\{3\}}(t) - E^{\{3\}}(t) \\ FQ^{\{3\}}(t) = Q^{\{3\}}(t) - F^{\{3\}}(t) \end{cases}, \tag{3}$$

where $\{3\}$ represents the three-dimensional space; t represents the time when the limb moves when falling; and $GT^{\{3\}}$, $AJ^{\{3\}}$, $BK^{\{3\}}$, $EP^{\{3\}}$, and $FQ^{\{3\}}$ represent the limb vectors of the human body's trunk, left arm, right arm, left leg, and right leg in the three-dimensional space, respectively. According to the different contribution of human motion expression in physical fitness, two joint angles are selected from each part as the active joint angle. The size of each joint angle of human body in three-dimensional space can be calculated by using the following formula, and the angular velocity of human joint angle can be calculated as:

$$\omega(t) = \theta(t+1) - \theta(t). \tag{4}$$

The motion sequence of human body is continuous and changes with time. The angular velocity value is produced after the change of front and rear torque joint angle. The limb vector and angular velocity of active joint angle are the performance of the overall movement of human trunk and limbs, and the change of the distance between joint points is reflected by the bending of human limbs and trunk. The human body also projects the xoy side plane from the left view direction. The distance from the five parts of the physical fitness personnel to the joint point is:

$$\begin{cases} d_{Gr}(x,y) = \sqrt{(x_G(t) - x_r(t))^2 + (y_G(t) - y_r(t))^2} \\ d_{CL}(x,y) = \sqrt{(x_C(t) - x_L(t))^2 + (y_C(t) - y_L(t))^2} \\ d_{CM}(x,y) = \sqrt{(x_c(t) - x_M(t))^2 + (y_C(t) - y_M(t))^2} \\ d_{GR}(x,y) = \sqrt{(x_G(t) - x_R(t))^2 + (y_G(t) - y_R(t))^2} \\ d_{GS}(x,y) = \sqrt{(x_G(t) - x_S(t))^2 + (y_G(t) - y_S(t))^2} \end{cases}, \tag{5}$$

where $d(x,y)$ represents the Euclidean distance between two joints of human body in physical fitness [15, 16]. In order to eliminate the differences of different individuals in physical fitness, each item in formula (3) and formula (5) is standardized

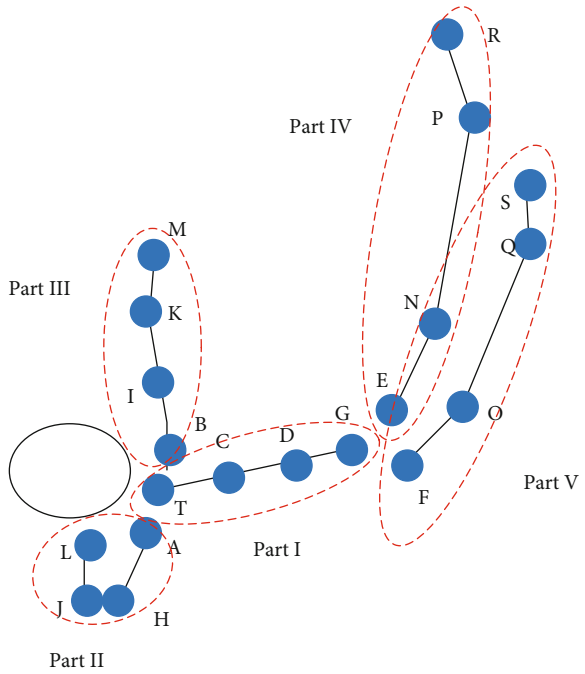

Figure 3: Division results of the five major parts of the human body.

with the width of human shoulder and the mean value of Euclidean distance between joints to obtain:

$$d_{AB}(x,y) = \sqrt{(x_A - x_B)^2 + (y_A - y_B)^2},$$
$$\bar{d}(x,y) = \frac{\sum_{t=1}^{n} d(t)}{n}, \tag{6}$$

where d_{AB} represents the width of the human shoulder and $\bar{d}$ represents the average of the Euclidean distance between the joints in the five major parts of the human body.

According to the above process, the limb vectors of the human body's trunk, left arm, right arm, left leg, and right leg in three-dimensional space coordinates are established, and the human fall motion features are extracted by using the distance between bones and joints.

3.2. Track and Adjust Human Body Falling Movements. In the expanded tracking target area, symmetrical vertical and horizontal tracking is carried out to generate and adjust the image of the moving target. Calculate the "centroid" coordinate (m_x, m_y) of the target area through formula (7), move the centroid coordinate according to the central area, and then generate the target tracking image of sports fitness personnel.

$$\begin{cases} m_x = \dfrac{\sum_{x\in R}\sum_{y\in R} x f(x,y)}{\sum_{x\in R}\sum_{y\in R} f(x,y)} \\ m_y = \dfrac{\sum_{x\in R}\sum_{y\in R} y f(x,y)}{\sum_{x\in R}\sum_{y\in R} f(x,y)} \end{cases}. \tag{7}$$

After the above processing, target tracking and adjusting the image sequence can well solve how the camera changes with the movement of sports fitness personnel. The adjusted image sequence only includes the athlete's limb movement and the action caused by falling, and cannot reflect the motion video of the camera in the original image.

By tracking the moving target of sports fitness, the activity area of sports fitness personnel is obtained. By calculating the centroid coordinates of the human fall action recognition area, the human fall action tracking image is generated to realize the tracking and adjustment of human fall action.

4. The Displacement Feature Extraction Model of Human Fall Motion in Posture Data Sequence Is Constructed

After formula (7) is used, the original fall action image in the posture data sequence can be obtained. Because the posture data sequence is affected by the time series, the fall action feature points in physical fitness will be displaced accordingly. In this study, the displacement feature extraction model of human fall movement in posture data sequence is constructed to improve the feature extraction accuracy of fall movement in sports fitness.

Set b_i as the sports fitness action information of frame t in the posture data sequence, and take it as the input value of human fall action displacement feature extraction model at time t, s_t represents the output value at time t, r_t represents the weight corresponding to the feature output, r_s represents the weight at the input of the original image, β represents the model activation function, and the current input posture data sequence is l_i, and then, the original input value of the model can be expressed as:

$$w = \beta(r_s l_i r_t l_{i-1} + r_t p_{i-1} g_i), \tag{8}$$

where p_{i-1} represents the output value of the feature extraction model at the last time. In order to obtain displacement data and calculate historical data, there are:

$$w_l = \beta(r_{ls} l_i r_{lt} l_{i-1} + r_{lt} p_{i-1} g_l). \tag{9}$$

The corresponding displacement data is obtained according to this formula, and the characteristic information of sports fitness fall action is obtained according to the displacement data. The feature extraction process is as follows:

$$g_l = w_l * \tan g(p_i). \tag{10}$$

The displacement characteristic data in the falling action image can be obtained from the above formula, and the displacement characteristic data can be saved, read, and reset according to the characteristic data processing method in the current method. If the displacement feature data does not meet the use requirements, the new feature data can be obtained by updating the long distance. In the process of characteristic data processing, the displacement data at each time is not of equal importance. Therefore, in the process of

proposing the characteristic data, it is necessary to use formula (9) to calculate the falling action image of the attitude data sequence for many times, set the corresponding loss function [17, 18], eliminate the difference information in the data, obtain the final falling action characteristic data, set it in the form of action label, and provide help for subsequent action recognition.

5. Realize Human Fall Motion Recognition Based on Pose Data Sequence

In the above design, the fall movement displacement data in the posture data sequence is extracted, and the extracted fall movement features will be used in this part. By tracking the displacement feature points, the process of human fall recognition is completed. A moving object will form a three-dimensional sports field in space, and the projection of the sports field on the imaging plane will form a two-dimensional field, which is the optical flow field. The optical flow field carries the three-dimensional information and motion parameters of the moving object, and the calculation of the optical flow field can indirectly obtain the three-dimensional motion information of the object. Because the images in this study are dynamic, the optical flow is calculated at the original input position of the displacement feature, and then, the collected action dynamic displacement is taken as the initial value of the subsequent position feature output, and the calculation process is repeated to obtain a continuously accurate optical flow estimation value.

In this study, the optical flow estimation will be obtained according to the relevant principles in the personalized learning algorithm [19, 20]. For the displacement feature point y of layer i in the fall action image Q not recognized in the attitude data sequence, the corresponding feature point of layer i in the preset action image R is m. Using the expression set above, it is necessary to determine the value range of optical flow vector ∂ [21], so that:

$$R = Q + m. \tag{11}$$

Then, the position of the action positioning point k is determined in the image to be detected, which can be expressed as:

$$k_q = \left(k_x^R, k_y^R\right)^T = \frac{k}{2^q}. \tag{12}$$

According to the obtained action positioning point information, the gradient matrix E of the fall action image is obtained by multiple operations using the L-K iterative algorithm [22, 23], and the optical flow in the fall action image of the attitude data sequence is determined. L-K (Lucas-Kanada) optical flow was originally proposed by Lucas-Kanada in 1981. This algorithm assumes that the motion vector remains constant in a small spatial neighborhood and estimates optical flow using weighted least squares. Since this algorithm is convenient when applied to a set of points in the input image, it is widely used in sparse optical flow fields. The specific formula is as follows:

$$\wp = E^{-1}\theta, \tag{13}$$

where θ represents the mismatch vector in the image, and the final optical flow estimation value is obtained by repeated operation with formula (11) and formula (12). Use the above calculation process to calculate the collected displacement feature points [24, 25], determine the dynamic characteristics of sports fitness action, and complete the identification of human fall action. The automatic recognition process of human fall action is summarized as Figure 4.

According to the model in Figure 4, the automatic recognition of falls of physical fitness personnel can be realized.

6. Experimental Demonstration and Analysis

6.1. Experimental Preparation. In recent years, a large number of action databases have been built at home and abroad to provide data sources for human fall action recognition. In this study, an automatic fall recognition method based on posture data sequence is proposed. In order to verify that this method has strong recognition effect, two recognition methods in reference [7] based on back propagation (BP) neural network and reference [8] based on OpenPose deep convolution network are selected as the control group, marked as current recognition method 1, and current recognition method 2, respectively, and the application experimental analysis process is completed by using the action database.

The experimental sports fitness actions used this time are obtained through video acquisition, and the images are taken at the same time through two groups of corresponding cameras, including 600 groups of experimental samples. The experimental action library does not include light conditions in the process of use, but only analyzes the sports fitness actions. At the same time, the main equipment used in the experiment is image acquisition equipment, which can reduce the transience and rapidity of human fall. The experiment adopts short-time acquisition, storage, and recording system to obtain and store the experimental image, which is composed of camera, acquisition card, cable, computer, and acquisition software. The camera parameters are shown in Table 1.

The overall experiment is completed in the platform built by MATLAB software under the configuration of Table 2.

The original target image obtained according to Table 1 before the experiment is shown in Figure 5.

For the processing of experimental data, each video segment is processed into a color image sequence, and then converted into a gray image sequence, and then, different recognition methods are used to recognize the falling action.

7. Analysis of Experimental Results

7.1. Experiment on the Division Accuracy of Physical Fitness Movements. In this experiment, the division accuracy of sports fitness action is taken as the first group of indicators to determine the image category division ability of the method in the experiment. The results are shown in Table 3.

According to the experimental results in Table 3, the classification performance of the proposed method is significantly

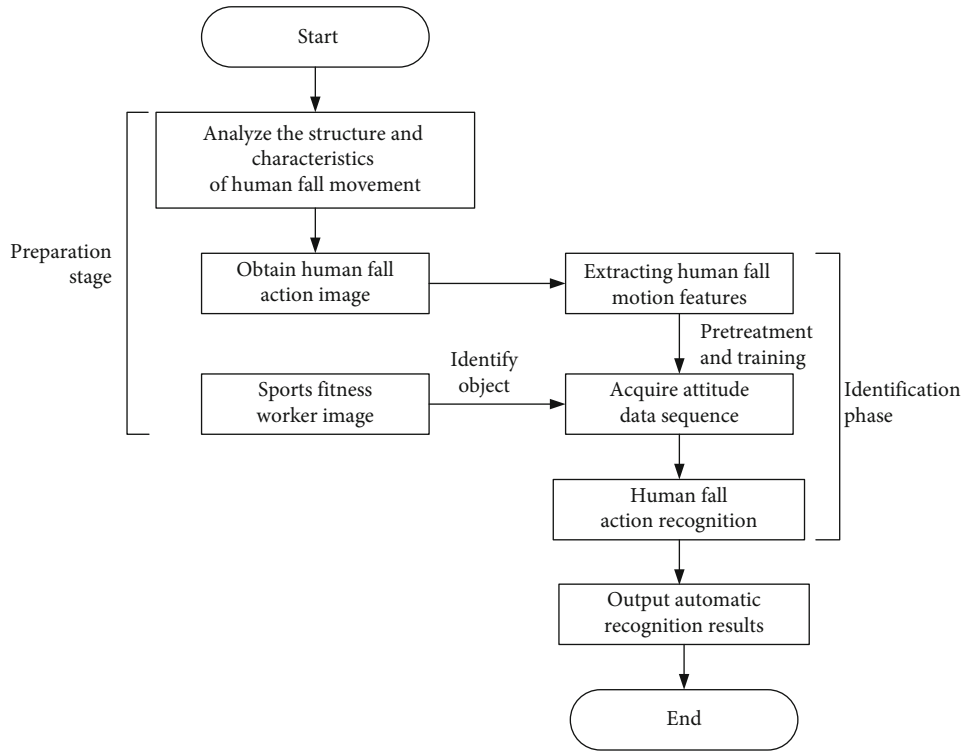

Figure 4: Schematic diagram of automatic recognition model of fall movement of sports fitness personnel.

Table 1: Camera parameter table.

Parameter name	Numerical value	Unit
Image type	Mono/color	—
Pixel depth	8/10	Bit
Pixel size	5.5×5.5	μm
Data output type	Camera link	—
Maximum frame rate	340	Fps
Maximum resolution	2048×1088	Pixels
Overall dimension	$63.5 \times 63.5 \times 44.1$	mm

Table 2: Experimental platform configuration.

Software and hardware	Quantity	Other instructions
E5-2698 V4 processor	1	—
NVIDIA TeslaV100 CPU	4	—
UBUNTU16.04	—	64bit
Tensorflow	—	1.8.0 edition
Python	—	3.6.0 edition

better than the current recognition method. In each experiment, the preset 5 kinds of actions are divided. The proposed method can carry out high-precision division of each action after use, and the action division accuracy is higher than 90%, ensuring the reliability of subsequent action recognition results. The current recognition methods 1 and 2 cannot achieve high-precision classification for some preset actions. The action classification accuracy of the two methods is lower than 87%, and there is often a problem that some action images cannot be classified. Using this method will have adverse effects on subsequent processing. Based on the above analysis results, it can be seen that the proposed method has stronger ability of action category division.

7.2. Action Detail Key Point Recognition Quantity Experiment. Taking Figure 5 as the search object, test the identification number of key points of fall details by different methods. The test results are shown in Table 4.

The experimental results show that the proposed method has only one error or omission in the identification of key points of action details. However, the number of errors and omissions in identifying key points of action details by the two methods compared is higher than 20. The recognition ability of the proposed method for action key points is significantly better than the current recognition methods. Through literature research, it can be seen that the recognition effect of key points of fall action directly affects the recognition effect of human fall action. Therefore, the application effect of the proposed method will be better than the current method.

7.3. Recall and Precision Experiments for Action Recognition. In order to quantitatively evaluate the proposed method, recall index and accuracy index are introduced to determine the recognition ability of each swing in human fall. The recall rate indicates how many positive examples in the sample are correctly identified (find all) the proportion of all positive examples that are correctly identified. Accuracy is the proportion of the total number of correct predictions

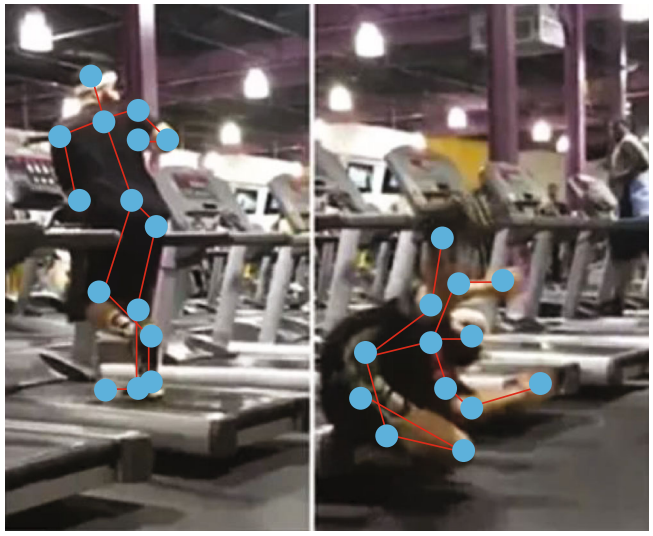

Figure 5: Experimental data set.

Table 3: Experimental platform configuration.

Result output times	The division accuracy of the proposed method for physical fitness movement/%	Current identification method 1 sports fitness action division accuracy/%	Current identification method 2 sports fitness action division accuracy/%
1	90.2	85.7	86.9
2	91.7	85.4	86.5
3	91.2	86.5	84.5
4	90.8	86.4	86.6
5	90.6	86.8	84.7

Table 4: Experimental platform configuration.

Action key points/piece	Number of action detail key points identified by the proposed method/piece	Current identification method 1: Number of action detail key points identified/piece	Current identification method 2: Number of action detail key points identified/piece
25	24	20	19
15	14	13	10
30	30	24	21
17	17	14	13
16	16	12	11

by the model. The calculation method of recall rate index and accuracy rate index is as follows:

$$\begin{cases} R = \dfrac{n_c}{n_c + n_m} \times 100\% \\ p = \dfrac{n_c}{n_c + n_f} \times 100\% \end{cases}, \tag{14}$$

where n_c represents the number of correctly recognized human falls, n_m represents the number of unrecognized human falls, and n_f represents the number of incorrectly recognized human falls.

For the experimental object shown in Figure 5, taking the number of human falls as the independent variable, after several iterations, the recall rates of the three action recognition methods are tested, and the results are shown in Figure 6.

It can be seen from the results of Figure 6 that the recall rate of action recognition of the three action recognition methods is basically the same when the number of human fall actions is less than 250. When the number of actions exceeds 250, the recall rate of human fall action recognition of the proposed method is higher and higher when identifying human fall actions; the highest recall rate is 90%. In the current recognition method 1, due to the low quality of the recognized human fall motion video, the recall rate of human fall motion recognition appears a turning point when the number of actions is 300 and begins to decrease gradually. The current recognition method 2 human fall

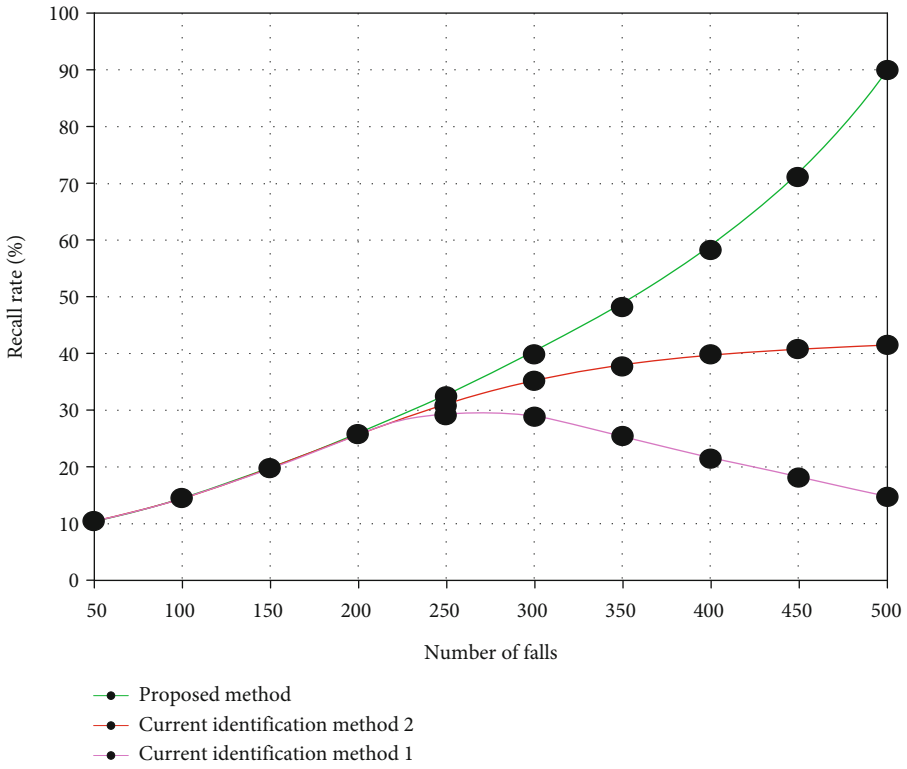

Figure 6: Recall test results of human fall action recognition.

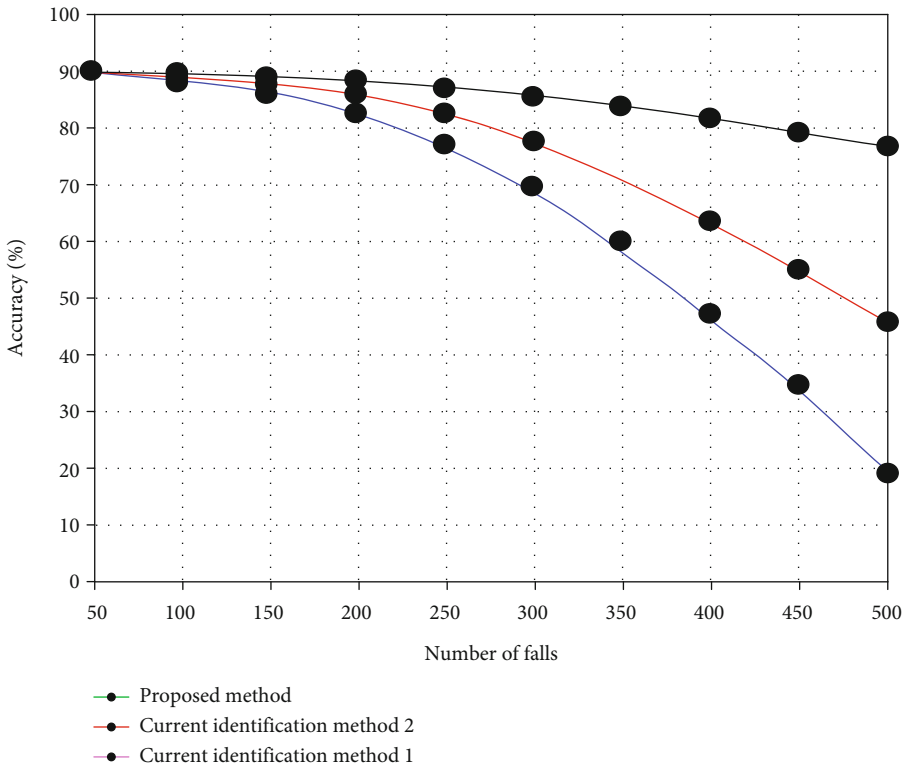

Figure 7: Accuracy test results of human fall action recognition.

action recognition method is affected by the movement of the camera. Although the recall rate of human fall action recognition shows an upward trend, the upward trend is relatively slow. Therefore, it can be concluded that the proposed method has good performance in the recall test of human fall action recognition.

The accuracy test results of human fall action recognition are shown in Figure 7.

It can be seen from the results in Figure 7 that with the increase of the number of human fall movements, the current identification method 1 and the current identification method 2 human fall movement identification method cannot be effectively distinguished when the movement direction of sports fitness personnel changes, resulting in the gradual reduction of the accuracy of human fall movement identification. When the proposed method is used to identify human falls, the accuracy of human fall recognition tends to decrease slowly. When the number of human falls reaches 500, the accuracy of action recognition is also as high as 77%.

In the process of this experiment, the recognition accuracy and recognition ability of the proposed method are analyzed from many angles. It is determined that this method has a certain application effect. At the same time, it is also confirmed that the application effect of this method is better than the current method.

8. Conclusions

Human fall recognition is an important part of the application of sports fitness recognition technology, and it is also an important research topic in the field of artificial intelligence interaction. In this study, the motion recognition method in the current attitude data sequence is used as the design blueprint, and the displacement feature and personalized learning method are used to optimize the design, so as to improve the recognition accuracy and effect on the existing basis. The color camera is used to collect the fall motion images of physical fitness personnel, and the fall motion features of the human body are extracted. In this paper, a feature extraction model of human falling action displacement from posture data sequence is constructed, and the automatic recognition of physical fitness human falling action based on posture data sequence is realized. The experimental results confirm that the classification accuracy of physical fitness actions of the proposed method is higher than 90%, and the recall rate of human falling action recognition can reach up to 90%, which effectively improves the recognition accuracy of human falling actions. In the future research, information fusion technology will be added to improve the methods proposed in this study, add the recognition process of voice and other information on the basis of action, use a variety of information to more accurately the information of sports fitness athletes, and capture the action types of sports fitness athletes.

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Retraction

Retracted: Research Based on the Application and Exploration of Artificial Intelligence in the Field of Traditional Music

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] Y. Yang and X. Huang, "Research Based on the Application and Exploration of Artificial Intelligence in the Field of Traditional Music," *Journal of Sensors*, vol. 2022, Article ID 5093044, 9 pages, 2022.

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Research Article

Research Based on the Application and Exploration of Artificial Intelligence in the Field of Traditional Music

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Traditional Chinese music has undergone trials and tribulations. To date, traditional music has been gradually improved, preserved, and passed down, both in terms of theoretical works and traditional music varieties. However, the current state of traditional music is still a cause for concern. Whether it is scholars engaged in the study of traditional music, universities, or local government agencies, there are still areas that need to be improved individually. The need to cultivate a future audience for traditional music and to make full use of new media such as the Internet is a priority at this stage. The emergence of any new technology is bound to have some impact on the existing social system, and the emergence of artificial intelligence is no exception. Due to the limitation of technology, only a small number of basic applications have been developed, and it is the future mission of research workers whether they can develop more advanced products for music lovers to experience on the basis of ensuring the basic maturity of these applications. In this paper, we introduce the convolutional deep belief network model based on the restricted Boltzmann machine and apply the convolutional deep belief network algorithm to the music melody recognition. Firstly, it was pretrained by an unsupervised greedy layer-by-layer algorithm. Then, the network parameters were fine-tuned by a supervised network training method, and the recognition ability of the model was improved by adjusting the network parameters. The experimental results show that the recognition effect of the system is more obvious under the condition that the length of music samples is 3 s, and the recognition effect is better when the number of model layers is 2 than that when the number of layers is 1.

1. Introduction

Traditional Chinese music is music with national characteristics created by the Chinese people using methods unique to the Chinese people and in unique forms. The unique musical forms of the Chinese people can be divided into two kinds: one is the visible and tangible material form, and the other is the invisible and intangible spiritual form. The invisible and intangible things like Peking Opera and Kunqu, which can be enjoyed by people, are the inherent forms of the nation. The guzheng, pipa, erhu, etc., which are both visible and tangible, are the inherent forms of the nation.

Since the Opium War, influenced by Western culture, Chinese traditional music has suffered a heavy blow during this period. China has a wide geographical area, many ethnic groups, and great differences between the north and the south, and the forms of traditional music are rich and diverse. In the face of the complex traditional music situation and the rapid development of economic construction, many varieties of traditional music have been left without successors and are on the verge of being lost. Scholars engaged in traditional Chinese music education and research have gradually established the new concept of "more preservation, less elimination," which is a valuable concept exchanged with great cultural loss and historical lessons, and we should stick to it. At the same time, we should lead the scholars in universities to go out and dig, collect, examine, and organize the traditional folklore and traditional music cultural heritage in their locations, or let the traditional culture into the campus, so as to experience

the traditional music more intuitively. Workshops and seminars of different scales have been held to give university scholars a more systematic and in-depth understanding of traditional music. The government has played an integral role in the preservation of traditional Chinese music. Local governments have established a dominant role in the preservation of traditional music, enacting laws, setting up institutions, increasing investment, improving programs, and establishing a system of transmitters, but this governmental involvement has also brought some disadvantages [1]. In some seemingly prosperous and thriving intangible cultural heritage projects, there is still a discontinuity. More often than not, they focus on theatrical performance, using modern advanced technology, adding choreography, sound, light, and electricity, so the purity and originality of folk music is lost, and only becomes an advertisement for the business and tourism industry to make profits. With the rapid development of the economy, technology has gradually penetrated into our lives and changed our way of life. Machines have replaced human labor, the labor trumpets have gradually disappeared, and the intervention of cell phones has gradually replaced the mountain songs by WeChat. Folk artists are also gradually replaced by electronic audio and new media, and more young people choose to go out of their hometowns and go to big cities to work hard, unwilling to learn a craft from their masters to support themselves. This has also put traditional music under greater impact, and the absence of inheritors means the disappearance of a traditional music. At the same time, the intervention of new media has given us a different aesthetic experience of music. The younger generation is more interested in the new wave of pop music and is no longer interested in traditional music.

The perilous situation of Chinese traditional music has attracted the attention of all sectors of society, as has the preservation of endangered species. There are two ways of preserving traditional music: one is "museum-style" preservation, which aims to accurately preserve traditional music in its original form [2]. In this way, future generations can hear and see the sounds and colors of traditional music that have disappeared. The main purpose is to preserve traditional music that is on the verge of being lost and has special value. Our country is vast and rich in traditional music, and to this day there are still undiscovered varieties of traditional music that are disappearing at an accelerated rate. It means that we have not protected the traditional music enough, and we should mobilize the strength of all departments and institutions to protect the traditional music to the maximum within the limited time. The second is that it survives in modern musical life [3]. That is, it exists in the colorful folk music life as well as in the modern professional music scene. When it comes to the dynamic preservation of traditional music, one has to mention composers. The most important thing to let tradition live is to adapt it to the aesthetics of contemporary young people, to meet their pursuits, and to create new musical models. The traditional elements of music are blended with modern music, trying to "change the shape of the music." This effectively preserves the essence of traditional music, while allowing more young people to accept and appreciate the beauty of traditional music.

Tones are the smallest units of music, and the combination of tones in a connected way, under certain logical changes, produces music [4]. Fundamentally, the musical tones in music originate from the metrical system, and different methods of calculating the metrical system result in different pitches of musical tones, which are combined together to form different musical systems. The difference of musical system means the difference of scale arrangement, which indirectly affects the presentation of tuning and the expression of musical functions. In its long history of development, Chinese traditional music has produced a variety of metrical calculation methods, forming a large system of metrical systems, including the three-part loss and gain meter, the twelve mean meter, and the pure meter. Different metrical calculation methods represent different metrical systems. The calculated musical pitch and scale systems also have obvious differences. According to the needs of musical expression and style, different systems of meter are used in different types of music and instruments. For example, the traditional music of the north is based on the three-point loss and gain rhythm, the southern music such as Cantonese music is based on the twelve mean rhythm, and the Guqin uses both the twelve mean rhythm and the pure rhythm system. Because of the differences in the scales of the different meters, it is impossible to achieve complete harmony across the musical genres, which fundamentally determines that traditional Chinese music cannot build a three-dimensional relationship between tones like Western music, but can only emphasize the sense of connection and extension between tones horizontally. In terms of musical expression, the focus is on the expression of each tone, i.e., the "tone cavity" as the focus of musical development.

With the popularity of the Internet, a technical invention linked to it is quietly entering the life of the public [5]. In recent years, the rise of big data, cloud computing, artificial intelligence, and other technologies has accelerated the development of various industries, and "Internet+" "big data+" "AI+" has gradually become the new normal of social development [6, 7]. In this context, the combination of technology and music has been a major trend, and the development of traditional music has also ushered in a new opportunity in this change. The integration and development of technologies such as big data and artificial intelligence with traditional music has greatly innovated the form of music dissemination and popularization, transforming the path of music dissemination from the original, one-way transmission by word of mouth to a multidimensional, diversified dissemination that is not restricted by geography or time and space. The application of artificial intelligence in the field of traditional music has brought a new artistic experience to the public. With the continuous innovation and breakthrough of information technology, the applications in the field of traditional music are gradually enriched, among which the more prominent ones are in the melody recognition, intelligent composition, instrument simulation, and virtual performance.

The main contributions of this paper are as follows: (1) Firstly, it is an important task to analyze the accurate

identification of traditional music melodies and retrieve the corresponding music information based on the melodies. This is crucial for the dissemination and preservation of traditional music. (2) Combined with artificial intelligence techniques, this paper investigates a traditional music melody recognition method based on deep neural networks. (3) By extracting the depth features in the frequency domain, the melody features are accurately identified and combined with a neural network classifier; the corresponding tracks are retrieved.

2. Related Works

2.1. Current Status of Traditional Music Research. Traditional music culture is a very important part of Chinese traditional culture. Therefore, the inheritance and development of Chinese traditional music culture has a very positive significance for the promotion and development of traditional culture, and it is a very effective way to promote the development of culture by music development [8]. In most people's opinion, learning music is more interesting than learning words. Therefore, it is possible for the public to inherit the national culture by learning traditional music, which not only helps to diversify the national culture but also allows the public to feel the national spirit in traditional music. Each nation has its own unique cultural heritage. Therefore, the public can feel the excellent culture of the nation through music, and in the process of learning music, they can continuously inherit the national culture, feel the essence of its spirit, and promote the development of the whole nation. With the continuous development of China's social economy, people's material life is constantly satisfied, but only the material enjoyment is far from enough; the spiritual life also needs to keep pace with the material progress. Most of the modern music works are marketed works, and the profit nature is obvious, which is not conducive to the cultivation of people's sentiments. But Chinese traditional music is different. Traditional Chinese music contains the kind and simple spirit of the Chinese working people, who have gained insights and created songs in their labor, or composed songs that represent their surging emotions because of their love for life. If this traditional music could be integrated into the lives of modern people, their spiritual and cultural dimensions would be enhanced.

All countries and ethnic groups in the world have their own traditional culture, and traditional culture is a kind of culture reflecting the characteristics and style of the nation, which is brought together by the evolution of civilization; therefore, the traditional culture of each nation is different. Chinese traditional music is a very attractive music culture that has developed under such fertile cultural soil. Chinese traditional music culture not only reflects the history of Chinese culture but also to a certain extent reflects the changes of modern culture. With the rapid development of social economy and increasingly rapid globalization, China is in very close contact with the outside world. Various cultures from the West have entered China through different ways and have had a great impact on Chinese cultural thought, and Western musical culture has also had a great impact on traditional Chinese musical culture. The way traditional Chinese music culture is transmitted and passed on has changed dramatically due to the intervention of Western culture. However, most of the Chinese traditional music culture has disappeared because of its inability to adapt to the new performance methods, which has put the Chinese traditional music culture into a crisis. Chinese traditional music culture is part of the world culture; therefore, the influence of the world culture on Chinese culture is actually very important, and we should treat Chinese traditional music culture with reverence and protection. How to protect and inherit the excellent Chinese traditional music culture, let the environment of Chinese traditional culture be well managed, and constantly seek the path of innovation in the case of foreign cultural intervention, and realize the sustainable development of Chinese traditional music culture, not only has great benefits for everyone and for the society but also helps a lot to improve the influence of Chinese nation in the world culture [9].

Melody is generally expressed in music in two basic forms, filling the main vocal parts of polyphonic music or existing independently as monophonic music; the former is represented by Western music, while the latter conveys the main characteristics of traditional Chinese music [10]. Limited by the three-dimensional thinking characteristic of Western culture, the development of Western music is more focused on wholeness and vertical logical construction, with melodic changes involving not only the horizontal ebb and flow of the tune line, but also the coordination of vertical harmonic and polyphonic relationships. It can be said that melody is only a part of the many vocal parts of Western music, and the development of tunes includes but is not limited to the change of the main melodic vocal part, which involves the joint cooperation between several vocal parts. Most traditional Chinese music is a single-line music, and the melodic voice part has an irreplaceable place in the piece. Some music even contains only a single melodic voice part, such as erhu, flute, suona, xiao, and other folk instruments with monophonic attributes, whose solo repertoire plays only a single melodic voice part. In the case of guzheng, pipa, and other multivoice instruments, as well as opera, folk songs, and folk music ensembles, although they can play two or even more voices at the same time, the dominant role is still played by the main melodic voice, and the development of other voices is based on the main melodic voice as the core of the minor variation. In essence, this ensemble can be characterized as a collection of multiple instruments interpreting the main theme in their different ways. Thus, the Chinese style of polyphonic tune development shows not the vertical coordination of musical tones but rather the emphasis on the horizontal echoing and modification of the main melody by each voice part.

2.2. Current Research on Artificial Intelligence in Music. Since the emergence of new music culture, the development of traditional music has gradually fallen into a dilemma. It has been the people's urgent pursuit to revitalize and promote the national culture, but geographical, institutional, and financial constraints have led to a modernization crisis in the development of traditional music as well. Along with

the popularity of the Internet, the inheritance and development of traditional music seems to have found a new opportunity. The combination of information technology and music can be traced back to the creation of "electronic music" in the early 20th century, an innovation that revolutionized the traditional status quo of music being dependent on the human voice and musical instruments. Then, driven by technology, music went through a digital era, mainly in the form of digital scores and digital sequencing, represented by MIDI [11]. Nowadays, the fusion of AI and traditional music has brought us a new experience of music art, and the term "Music AI" (Music Artificial Intelligence) has emerged [12]. Take the way the guqin is played in traditional music as an example. In the early days, the ancient people invented the diminutive score in order to preserve the fingering, string order, and pitch of the guqin, but, unfortunately, most of the scores have been lost in the flood of history.

The Shanghai Conservatory of Music and the Huawei team are working on how to use AI to decipher these "heavenly books" and reconstruct ancient music. The process requires a computer programmer to program the notation rules of the reduced-word scores, and then a smart device to take pictures of the scores and translate them into short scores for inclusion in the database. Then, through cloud computing and other technical means, the neural network model is trained on the server to carry out deep learning of the diminutive scores, so that the AI has the ability to recognize the pitch pattern of the diminutive scores, and this operation is to return the traditional music to its original nature with the help of AI in modern society [13, 14]. Since ancient times, there are countless melodic fragments with various characteristics, and it is difficult to find a piece of music from the preserved melodies, but human beings have used their wisdom to find a solution. So far, the function of "melody recognition" has gone through three stages: first, the human self-identification stage, which requires the recognizer to have a large reserve of musical melodies, which is obviously more difficult; second, the audio file input recognition, which must be done by computer, and the operator needs to have skilled computer operation skills. The third is the intelligent recognition with the help of AI technology, which is based on the voice recognition function of intelligent devices and not only broadens the traditional music retrieval method but also shortens the retrieval time. Similar to the traditional way of retrieving a given audio file, intelligent recognition requires the device to first store a large amount of pitch, melody, rhythm, and other basic components of music. The recording of human and instrumental sounds is required to form a music data resource library inside the device, and then computer algorithms are used to classify and form a melody feature library and compile feature codes for each timbre and each melody. Compared with the search method for a given audio file, AI intelligent recognition does not require tedious steps such as format conversion and file input, and can directly recognize the melody according to the music played. When the intelligent device receives a melody signal, it will use computer algorithms to filter and identify whether the melody fragment exists in the existing music data library of the device, and then extract the pitch and rhythm signals that match the library and match them with the existing melody to arrive at the answer [15]. This function not only identifies the name of the music fragment by the melody fragment but also presents the relevant information of the music, such as composer, performer, and composition background, in a comprehensive manner by using the Internet and big data [16].

A common feature of early melodic feature representations is the autocorrelation method of pitch extraction in the time domain. The melody is represented as U, D, S or U, D, R, indicating that the pitch of a note is higher, lower, or equal to the previous note of this note, respectively. Based on this representation, the melodic feature matching algorithm is transformed into a string matching algorithm. This representation basically does not consider the rhythmic characteristics of the music, and these methods achieved a hit rate of 70%-90% in nearly 10,000 songs. The drawback of this approach is that the music files are required to be in MIDI format, since MIDI describes melodies in sequences of events that are easily converted into the sequence of notes required by the feature matching algorithm. Deep learning is an emerging branch in the field of machine learning that is able to extract more abstract features of data by simulating the structural features of the human brain [17, 18]. Applying convolutional neural networks in melody extraction requires first converting sound files into image files that are convenient for convolutional neural networks to process, and then performing feature extraction with the help of some methods of image feature extraction, and these converted images can be sound spectrograms, and this method that requires converting sounds into images before performing melody extraction is a challenge in terms of computational effort [19].

3. Algorithm Design

3.1. Convolutionally Restricted Boltzmann Machine. In the standard restricted Boltzmann machine (RBM) [20], all observed variables are related to different parameters in the hidden layer. For the convenience of explanation and understanding, the model principle is illustrated below from the image perspective. When using the RBM to extract global features from a complete image, no consideration is given to how large the image is. This is because when the dimension of the image increases, the number of connected weights in the RBM becomes very large, resulting in complicating and slowing down the operations during training updates and other processes. In fact, only a small number of parameters are needed when tracing spatially local features of an image, and these parameters provide reusability when extracting features from other different places of the image. Therefore, to solve this problem, an extension of the RBM model, the convolutionally restricted Boltzmann machine (CRBM), is proposed.

CRBM is very similar to RBM in that it is a model consisting of a visible layer and a hidden layer, both of which are matrices of random variables. The visible layer matrix in CRBM can be represented by a pair of images, and local blocks of images can represent parts of the visible layer matrix (subwindows). Local perceptual field and weight sharing are features of CRBM; in other words, the hidden and visible layers are locally connected to each other and the weights of the model are shared. A CRBM feature extractor is shown in Figure 1. A feature map represents each cluster of hidden layer units. Each feature map is a binary matrix that represents a single feature in different positions of the input variables, i.e., each feature map represents one feature. Thus, the hidden layer cells can be separated into different feature maps so as to represent the different features of the visible layer cells at different locations.

From Figure 1, we can see that CRBM is connected to the visible layer cell V and the hidden layer cell H by $K3 \times 3$ feature extractors: $W_1 W_2, \cdots W_k$. The hidden layer cells are separated into K submatrices called feature maps: swab, from $H_1, H_2, \cdots H_k$. Each hidden layer cell is represented as a specific feature extracted from a visible layer 3×3 neighborhood cell. A cell in a feature map represents the same feature in different places in a visible cell V.

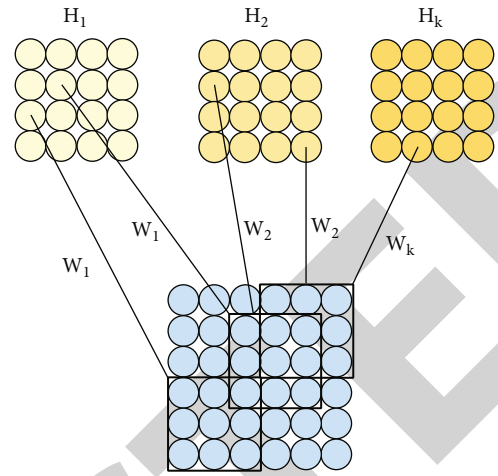

Figure 1: CRBM feature extractor.

3.2. Convolutional Deep Belief Network. Convolutional deep belief networks (CDBN) is a hierarchical probabilistic generative model based on a stack of CRBMs. The difference between deep belief networks (DBNs) [21] and CDBNs lies in the use of convolution, which can also be interpreted as a neural network composed of DBNs combined with the features of CNNs (i.e., local perceptual field and weight sharing in the model). After obtaining the features of the training samples by convolution, if we use these obtained features directly, we may face a very large amount of computation [22, 23]. And learning a classifier with a very high dimensional feature input is inconvenient and prone to overfitting. To solve such a problem, the convolved features are likely to be applicable in different regions of the sample, and to describe samples with large dimensionality, one solution is to perform aggregation statistics on features at different locations [24]. One can calculate the average (or maximum) value of a particular feature over a region of the sample. This reduces the dimensionality and at the same time is less prone to overfitting. This aggregation operation is called pooling. In another way, pooling can also be understood as downsampling.

The CRBM is refined using probabilistic maximum pooling [25], which is the operation of pooling the maximum value of a neighborhood of the hidden layer in a probabilistic manner, and the CRBM with probabilistic maximum pooling is used as the basic component of CDBN in this paper, and the model is shown in Figure 2.

The spectral features of the training and testing data are first extracted from the original music data. The spectral features of the music data are used as the input of the CDBN network to extract the CDBN features of its first and second layers, respectively. The first and second layers of CDBN are

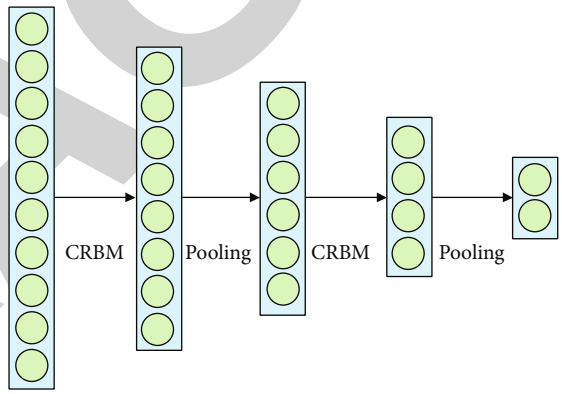

Figure 2: CDBN model structure.

pretrained by an unsupervised greedy layer-by-layer algorithm. The music features extracted from the CDBN correspond to CDBN1 and CDBN2.

The first layer of CDBN has a base K of 300 groups, a filter length W_k of 6, and a maximum pooling size of 3. The second layer K has 300 groups, a W_k of 6, and a maximum pooling size of 30. Firstly, the spectral features are extracted for each segment of the music data of the training data, and the music signal is represented in the form of a spectral vector. The Fourier transform of each signal frame is obtained to represent the music data, and the length of each speech signal frame is 20 ms, and the overlapping region is 10 ms, as shown in Figure 3.

CDBN is pretrained by an unsupervised greedy layer-by-layer algorithm. After all layers are pretrained, the output layer with node L is added to the top of the network, and then the network parameters are fine-tuned by a supervised network training method, which in turn leads to better network performance. The optimization goal of the neural network is to optimize E_{in} by adjusting the parameters W so that the final model output is closest

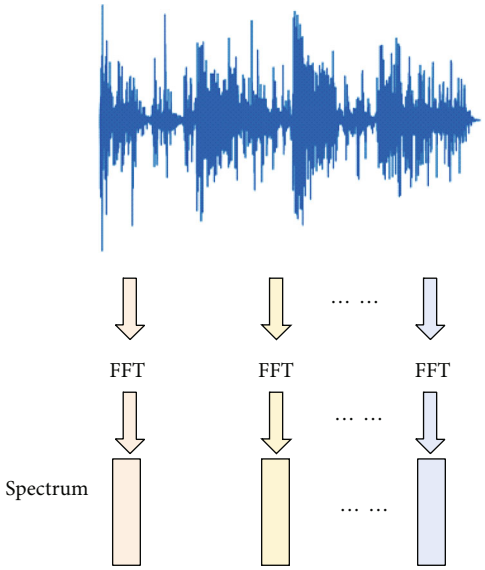

Figure 3: The process of obtaining a frequency domain signal from a time domain signal.

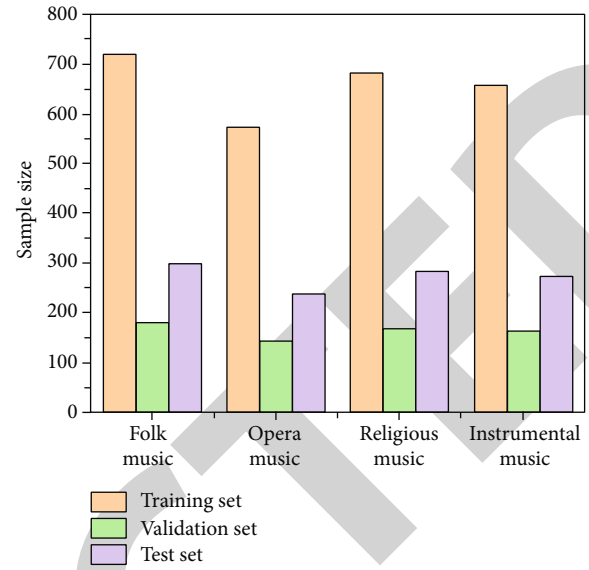

Figure 4: Dataset division.

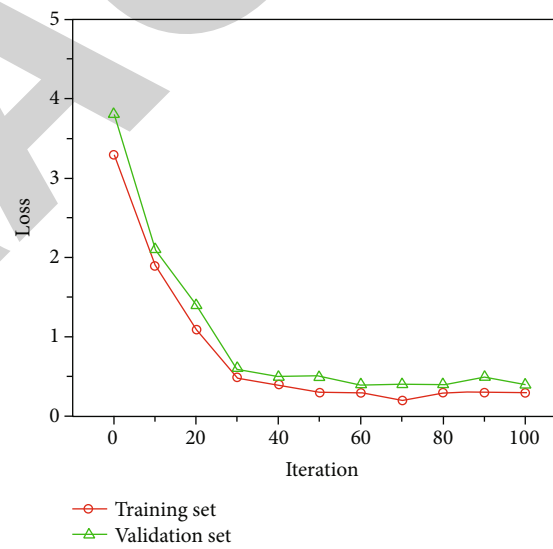

Figure 5: Loss variation during training.

to the target value, and it is necessary to find $\partial e_n/\partial w_{ij}^{(l)}$.

$$e_n = \left(y_n - s_1^{(L)}\right)^2 = \left(y_n - \sum_{i=0}^{d(L-1)} w_{i1}^{(L)} x_1^{(L-1)}\right)^2. \quad (1)$$

For the output layer: $0 \le i \le d^{(L-1)}$

$$\frac{\partial e_n}{\partial w_{i1}^{(L)}} = \frac{\partial e_n}{\partial s_1^{(L)}} \frac{\partial s_1^{(L)}}{\partial w_{i1}^{(L)}} = -2\left(y_n - s_1^{(L)}\right)\left(x_i^{(L-1)}\right). \quad (2)$$

For other layers: $1 \le 1 \le L\,; 0 \le i \le d^{(i-1)}\,; 1 \le j \le d^{(l)}$

$$\frac{\partial e_n}{\partial w_{t1}^{(l)}} = \frac{\partial e_n}{\partial s_j^{(l)}} \frac{\partial s_1^{(l)}}{\partial w_{i1}^{(l)}} = -2\delta_j^{(l)}\left(x_i^{(i-1)}\right). \quad (3)$$

From the above, it is clear that $\delta_1^{(L)} = -2(y_n - s_1^{(L)})$. The other $\delta_j^{(l)}$ is solved as follows:

$$\delta_j^{()} = \frac{\partial e_n}{\partial s_j^{(l)}},$$

$$\delta_j^{(l)} \Rightarrow x_j^{(l)} \overset{x_i^{(l)}}{\Rightarrow} \begin{bmatrix} s_1^{(l+1)} \\ \vdots \\ s_k^{(l+1)} \\ \vdots \end{bmatrix} \Rightarrow \cdots \Rightarrow e_n. \quad (4)$$

Here, $\delta_j^{(l)}$ can be calculated from $\delta_j^{(l+1)}$, $\delta_j^{(L)}$ is known, so $\delta_j^{(l)}$ can be obtained by reverse calculation. Thus, the final network parameters can be obtained from the input forward to the output, and then from the error backward to solve the parameter differentiation for parameter optimization. The parameters $\{W_k\}, b, c$ of the CDBN are obtained by learning from the contrast scatter of the input training sample set. The values of the hidden variables are obtained by reconstructing the distribution of the CDBN from the input units using Gibbs sampling, and then the values of the observed variables are obtained from the hidden units.

4. Experiments

4.1. Experiment Preparation. The experimental data are traditional music collected on the web, with a total of 4394 music melodies, containing four categories: folk music,

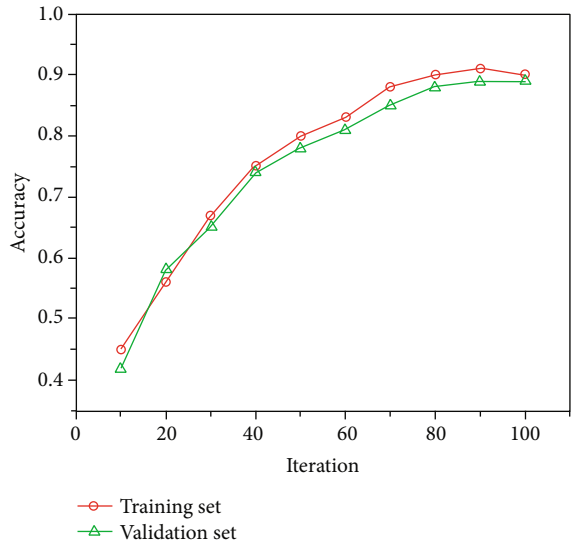

Figure 6: Melody matching accuracy curve during training.

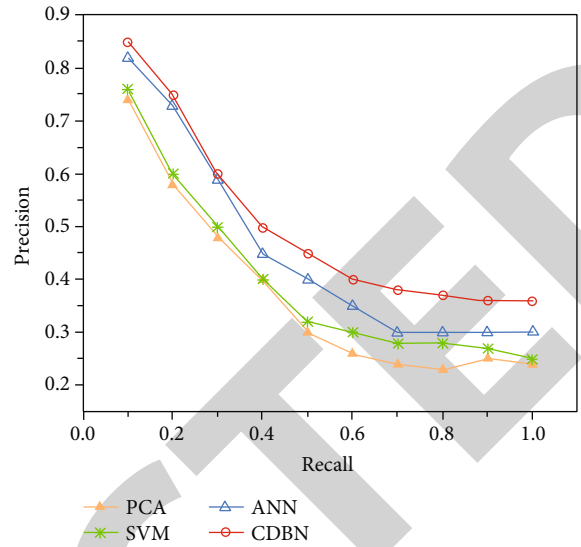

Figure 7: Comparison of precision-recall curves of different models.

Table 1: Relationship between variation in the number of layers and recognition rate.

Layer	Test set recognition rate (%)
1	83.1
2	89.2

Table 2: Comparison of experiments with different lengths of music.

Duration of music	Recognition rate (%)
10s	68.56
8 s	79.23
6 s	82.59
5 s	85.36
3 s	87.71

opera music, religious music, and ethnic instrumental music. 60% of them are used as the training set, 15% as the validation set, and 25% as the test set. Figure 4 shows the specific dataset division.

The experiments are built in the deep learning framework PyTorch environment, the experimental system environment Ubuntu 16.04 operating system, equipped with two Nivdia 1080TI graphics cards, 32G RAM. The network model is trained using Adam optimizer with 100 Epochs. The initial learning rate is 0.01 and the termination learning rate is 0.0001 with a cosine learning rate. The loss curves of the training and validation sets of the CBDN model proposed in this paper during the training process are shown in Figure 5. The model converges after approximately 40 iterations. Figure 6 shows the accuracy of matching the output of the model with the target melody during the training process.

4.2. Ablation Experiments. In this paper, the first CDBN layer features and the second CDBN layer features are compared and the experimental results are shown in Table 1. From the results in the table, we can see that the features learned in the first CDBN layer do not give better results than the features learned in the second CDBN layer for song fragment recognition.

For different fragments as independent samples, different experiments were conducted in this paper, and the experimental results are shown in Table 2. As can be seen from the table results, the short-time recognition performance is more superior, i.e., the recognition rate is higher when 3 s fragment statistical features are used as classification features.

4.3. Comparison Experiments with Other Models. We compared the model in this paper with several currently used music retrieval models on a database for web retrieval. The methods compared include principal component analysis (PCA), support vector machine (SVM), and artificial neural network (ANN). These models can be broadly classified into two categories: linear and nonlinear, with the first two being linear methods and the neural network-based methods being nonlinear. We use the accuracy and recall curves to evaluate the models, and the results are shown in Figure 7. It can be found that the traditional linear model does not perform well enough in retrieval, while the nonlinear model based on neural network has better performance in cross-modal tasks, and the CDBN in this paper works better than the traditional method. In addition, we also verified the model's recognition effect on different categories of traditional music on the test set, and the results are shown in Table 3 and Figure 8. The music melodies of different categories are very different. It can be seen that the recognition rate of the

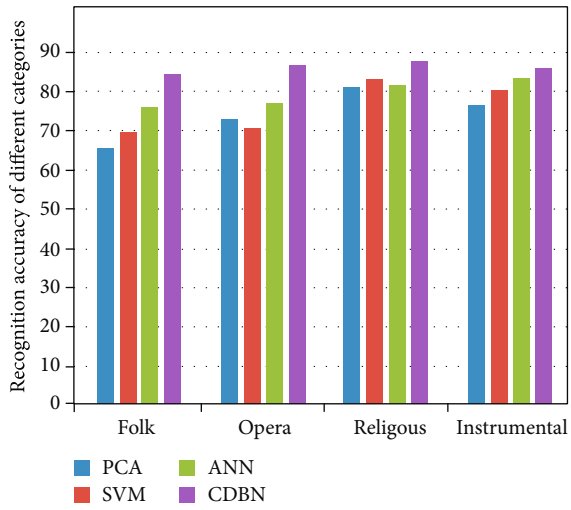

Figure 8: Recognition accuracy of different categories (%).

Table 3: Recognition accuracy of different categories (%).

Model	Folk	Opera	Religious	Instrumental
PCA	65.39	72.76	80.87	76.33
SVM	69.34	70.58	82.97	80.24
ANN	75.96	76.87	81.29	83.22
CDBN	84.32	86.78	87.56	85.94

method in this paper is more balanced for different categories, while the other methods tend to receive the influence of melodic distinction. This is due to the robust feature representation of the convolutional layer.

5. Conclusions

The combination of technology and art has become an unstoppable trend, and "AI+traditional music" has gradually penetrated into many aspects of singing, playing, and composing. Although there are still many problems to be solved, musicians still see new opportunities in the innovation path of Chinese traditional music, and we are looking forward to more applications being developed and put into use. Let us take a positive attitude and, with the attention of the national government and the care of the community, rely on the power of technology and academia to build a new ecological civilization, so that traditional Chinese music can have a broader future with the help of AI. Throughout thousands of years of history and civilization, society has always been in a constant state of change and progress, and the same is true for the development of traditional music. AI, as a product of the technological revolution of the new era, provides new ideas and methods for the dissemination of traditional music. In order to achieve sustainable development, traditional music must be in line with the times. In the current development situation, it seems that the combination of AI and traditional music will have a new and broader development prospect, but we must also work on it from various aspects.

To address the shortcomings of existing algorithms in traditional music melody recognition and retrieval, this paper introduces deep learning theory and applies it to the process of music information retrieval. This paper introduces the CRBM model and convolutional deep belief network and applies the deep belief network algorithm to song recognition. The effects of traditional music sample length and the number of model layers on the recognition performance are investigated experimentally. The experimental results show that the method in this paper can accurately identify and retrieve music based on melody. In the future, we plan to conduct research on the use of recurrent neural networks for applications and exploration in the field of traditional music.

Data Availability

The datasets used during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that they have no conflict of interest.

Acknowledgments

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Research Article

In-Depth Research and Analysis of Multilabel Learning Algorithm

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Multilabel learning (MLL), as a hot topic in the field of machine learning, has attracted wide attention from many scholars due to its ability to express output space polysemy. In recent years, a large number of achievements about MLL have emerged. Among these achievements, there are several typical issues worthy of attention. Firstly, the correlation among labels plays a key role in improving MLL model training process. Many MLL algorithms try to fully and effectively use the correlation among labels to improve the performance. Secondly, existing MLL evaluation metrics, which is different from those in binary classification, often reflects the generalization performance of MLL classifiers in some aspects. How to choose metrics in algorithms to improve their generalization performance and fairness is another issue that should be concerned. Thirdly, in many practical MLL applications, there are many unlabeled instances due to their labeling cost in training datasets. How to use the wealth information contained in the correlation among unlabeled instances may contribute to reducing of the labeling cost in MLL and improving performance. Fourthly, labels assigned to instances may not be equally descriptive in many applications. How to describe the importance of each label in output space to an instance has become one of research points that many scholars have paid attention to in recent years. This paper reviews the MLL-related research results of correlation among labels, evaluation metric, multilabel semisupervised learning, and label distribution learning (LDL) from a theoretical and algorithmic perspective. Finally, the related research work on MLL is summarized and discussed.

1. Introduction

Traditional supervised learning assumes that each sample corresponds to a single class label that is unique in the output space, which is binary classification. But many real-world learning tasks do not fit the hypothesis. For example, an image of Yao Ming smiling while holding a basketball in classification tasks can be labeled "movement," "basketball," "NBA superstar," or "smile." Another example is the article "Moonlight" in text categorization tasks, which might cover the topics "essay" or "zhu ziqing" labels. In these cases, an example is polysemous. In other words, an example is associated with multiple class labels in output space. In order to solve these problems, there appear multilabel learning frameworks [1].

A multilabel learning framework was originally applied to text categorization tasks. Because of its ability to express the world more accurately, MLL has attracted wide attention from researchers and has been gradually applied in applications such as automatic annotation of multimedia information, Web mining, information retrieval, and tag recommendation [2, 3]. A lot of influential MLL methods have been proposed in the recent years, and more and more detailed and deep-level problems have gradually become clear and solvable. A number of scholars have systematically studied and combed the research progresses towards MLL. Tsoumakas et al. gave a structured representation of sparse literatures on MLL methods with comments on their advantages and disadvantages. Label cardinality and label density were defined to quantify the multiple labels properties of a dataset, and some comparative experimental results were provided to demonstrate the performance of different MLL methods in their work. Zhang et al. providing the fundamentals on MLL including formal definition and evaluation metrics. And in their work, some representative MLL algorithms are highlighted and related analysis is carried out [4]. From the research in recent years, several research hotspots on MLL have attracted the interest of scholars. In

order to inspire the future research for scholars interested in MLL, we combed the relevant works. In this paper, we will focus on the following: (1) the correlation among labels, (b) evaluation metric, (c) multilevel semisupervised learning, and (d) distribution characteristics of labels.

2. The Unified Description of the Relevant Concepts

For the sake of further description, here, we give the formal description on the relevant concepts on MLL.

Assume $X = \mathbb{R}^d$ expresses a d-dimensional instance space, in which each instance could be expressed as a vector $x_i = \{x_{i1}, x_{i2} \cdots .x_{id}\} x_i \epsilon X$; $Y = \{y_1, y_2 \cdots .y_q\}$ expresses q -dimensional class label space. A multilabel learning framework is to learn a mapping function $h : X \longrightarrow 2^Y$ from instance space X to the subsets of class label space Y in given training set $D = \{(x1, Y1)(x2, Y2) \cdots .(x_m, Y_m)\}$ ($Y_i \subseteq Y$ was a subset of label space Y, $i \in [1, m]$), noting the size of D as $|D|$. For any unknown instance $x \in X$ in a testing set, a multilabel classifier will predict a set $h(x) \subseteq Y$ as a predicted label set of x. In general, most of the multilabel learning model will attune h to a real-valued function $f : X \times Y \longrightarrow \mathbb{R}$, and $f(x, y)$ can be expressed as a confidence value with which the MLL model predicts $y \in Y$ was the label assigned to x. Thus, $f(x, y)$ will make the label y' corresponding to lager output as relevant labels of x, while making the label y'' corresponding to smaller output as irrelevant labels of x, that is, $f(x, y') > f(x, y'')$. The above-mentioned classification prediction model h usually sets a threshold value t in which cloud divides the label space Y into two parts: relevant and irrelevant segmentation. If the real value classifier model $f(x, y) > t$, we can consider y relevant labels of x; otherwise, y is considered irrelevant labels of x.

There are usually two approaches to select t: One is for the fixed constant (eg., 0.5); another one is for the variable function [5].

And it is worth mentioning that there are several concepts related to MLL. Multiclass classification deals with the cases in which each instance is associated with only one label, while the label belongs to a label set that consist to more than two labels. For example, an image of fruit could be associated with apple, banana, orange, or peach, but it could not be associated with more than one of them. If we describe binary classification as "True-False," multiclass classification could be described as a "Single-Answer" from multiple items, and multilabel classification could be described as "Multiple-Answer." Their relationship is shown in Figure 1

Multi-instance learning refers to the cases in which some instances are packed into a bag as an example, and each example is associated with only one binary label. In contrast to MLL which handle the polysemy of labels in output space, multi-instance learning handles the polysemy of examples in an input space [6–8]. What is interesting and important is that if we combine multilabel with multi-instance, we would get a new learning framework—MIML (Multiple Instances Multiple labels) that could deal with complex and ambiguous cases. For example, we can put an image including sky, cloud, lake, and trees into a bag (without being splitted) as an example, and based on these examples, MIML could be trained to predict whether a new instance is correlated to the labels (sky, cloud, lake, and tree). There are a number of attempts towards exploiting MIML in real applications such as text categorization and image classification [9].

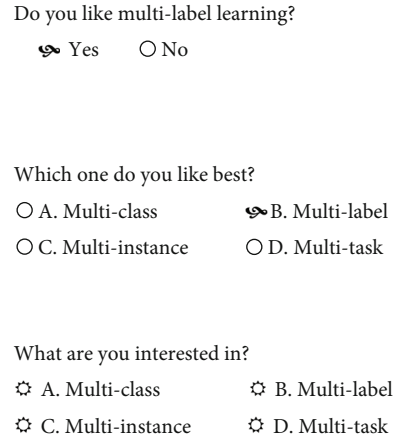

Figure 1: The distinctions about binary classification, multiclass classification, and multilabel classification.

Ordinal classification in multilabel learning tries to generalize each original label ($y_{ij} \in \{-1, 1\}$) to a member of graded label series ($y_{ij} \in \{m_1, m_2 \cdots, m_k\}, m_1 < m_2 < \cdots, < m_k$). It does not output the defined class labels but the fuzzy label series. This case may be reasonable in practical application, because it may be hard to answer "yes" or "no" exclusively but easier to answer "somewhat" or "almost." Give an example of emotional classification of songs; the labels associated with a song may be not "angry-aggressive" at all, somewhat "quiet-still," almost "relaxing-clam," fully "happy-pleased" ("angry-aggressive"<"quiet-still"<"relaxing-clam"<"happy-pleased"), while the datasets on this case is few as far as we know [10].

Multitask classification attempts to train multiple tasks in parallel by sharing representations and induces bias information on related tasks to improve the generalization performance to others. Just like the correlation between labels for MLL, the bias information for related tasks is helpful if we want to extend tabula rasa learning to complex tasks. For example, each of the following: the number of lanes on the road, the location of road edge, the location of the road center, and the intensity of road surface, can be regarded as a task in the field of road-tracking, respectively. If we take a label as a task, MLL could be considered a special case of multitask. The differences between them lie in two aspects at least: one is that all the examples in MLL need to share the feature space while those in multitask need not; another one is that the goal of MLL is to obtain a label subset while those of multitask is to improve generalization performance using bias information. Some literatures indicate that techniques for multitask classification may be used to benefit MLL [11].

3. The Correlation among Labels

3.1. Category of Label Correlations. The key challenge of MLL might be increased dramatically with the increase of the label space scale $|Y|$. The mainstream solution is to use correlation among labels in Y to lower learning space of model. For example, "blue sky" label usually appears at the same time with the "clouds" label; News pages marked as "politics" usually do not appear "entertainment" label. Formally speaking, $P(y_i) \neq P(y_i|y_j)$. Strategies using the correlation among labels can be roughly divided into three categories based on its order: (1) the first-order strategy is designed to consider a single label to correspond to one binary classification, respectively, ignoring the relationship with other remaining labels. The strategy is simple and efficient, while the performance may not be optimal. (b) The second-order strategy is designed to consider the pairwise relation between labels, such as related and irrelevant labels through the label ranking. The performance is better than the first-order strategy, while the correlation between labels in practical application will surpass the premise of the second order relationship. (c) High-order strategy is designed to consider higher order relation among either all or random subsets of labels, such as considering the influence of the rest of all on each label. The ability in expressing the relationship is the strongest while its computational complexity limits applications to small scale.

On the other hand, the correlation among labels can be divided into unconditional and conditional correlation in terms of its probability distribution [12]. Unconditional correlation refers to the expected value of correlation globally, i.e., the expected value of correlation among labels associated with all instances in an input space. Normally speaking, the correlation among labels refers to the unconditional correlation, whereas conditional correlation captures the correlation among labels given a special instance $x \in X$.

3.2. Why Label Correlation Work. The correlation among labels plays a key role in improving MLL model training process. Considering unconditional second order as an example, let b_i and b_j denote the decision boundaries corresponding to labels $y_i \approx h_i(x)$ and $y_j \approx h_j(x)$ separately, and α denotes the angle between b_i and b_j, as shown in Figure 2 (a rectangle represents an instance associated withy_i; a round represents an instance associated withy_j):

And y_j can be expressed as

$$y_j = f(y_i) + g(x), \tag{1}$$

in which $f(\bullet)$ is a dependence function between y_i and y_j, the strength of which is related to α; i.e., with the increase of α, the impact strength of $f(\bullet)$ decreases gradually. And $g(x)$ is a minimum about x, i.e., $g(x) \approx 0$ with high probability or for most instances. Since $g(x)$ plays a less important role, it is reasonable to believe that y_j is determined by $f(y_i)$ in formula (1). That can be illustrated in Figure 3 in which the performance of MLL on the ordinate axis is expressed by subset 0/1 loss.

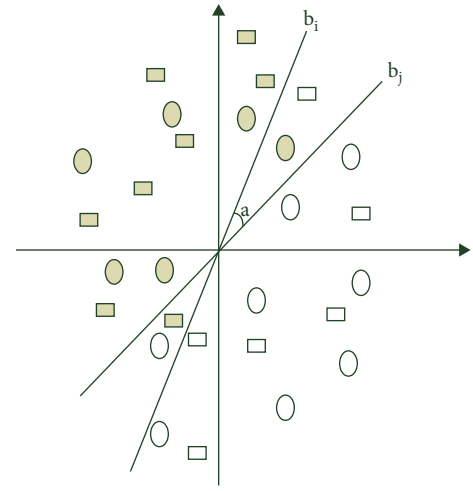

Figure 2: The angle between decision boundaries.

3.3. How to Obtain the Correlation among Labels. The correlation among labels is so important that many researchers are interested in this topic: how to obtain it. In fact, this is challenging. To the best of our knowledge, there are four methods to solve this problem. (1) The first one is statistics based on the number of the instances assigned to each label, such as chi-square, difference in proportions, and likelihood ratio test, on the number of these instances [13]. Taking the chi-square test as an example, assume the frequency counts of instances related to label y_i and y_j cooccurrences as presented in Table 1.

According to the chi-square test,

$$x^2 = \frac{(ad - bc)^2(a + b + c + d)}{(a + b)(c + d)(b + d)(a + c)}. \tag{2}$$

The greater the value of x^2, the greater the likelihood that the hypothesis of "label y_i and y_j are correlated" holds. Thus, the correlated label pairs can be sorted according to x^2 value in descending order. (2) The second one is based on the similarity of features assigned to different labels. This method assumes that if there are sufficient instances assigned to label y_i and y_j that contain some similar features it is reasonable to believe y_i and y_j are correlated. Specifically, for any instance x_i in D, if it is assigned to y_i and y_j simultaneously, put it into set A. Note the common features for all instances in A as a vector $f_c = \{x_m \cdots .x_n\}$; the larger the $|A|$ and $|n - m + 1|$, the more reason to believe that y_i and y_j are correlated. Association rules and principal component analysis may be helpful in terms of similarity in feature space. It is worth mentioning that if the dimension of the features in the training set D is too large (i.e., $q \ll d$), the influence of a single label will be diluted. (3) The correlation among labels could be provided to MLL classifier manually using domain knowledge. For example, a hierarchy among labels or dividing labels into several mutually exclusive subsets in a practical application may be helpful in reducing computational complexity and improving accuracy. (4) Using the

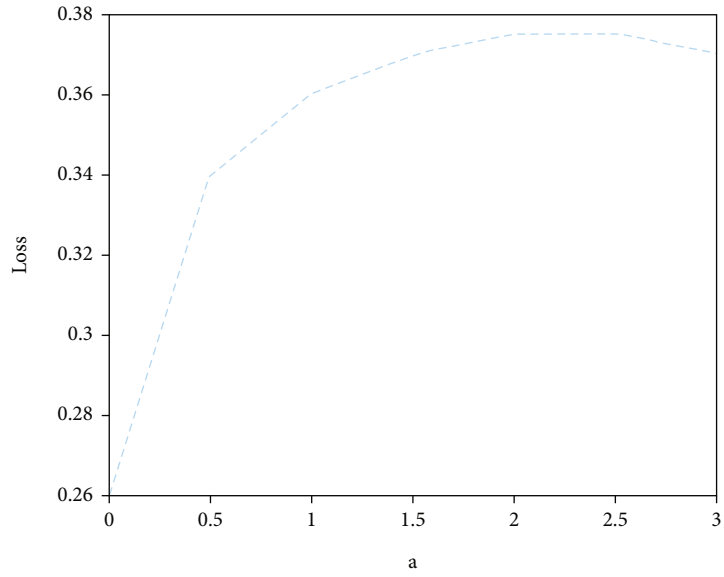

Figure 3: The relationship between the performance of MLL and angle α.

Table 1: Frequency counts of instances related to label.

	y_i	$\neg y_i$
y_j	a	b
$\neg y_j$	c	d

feedback from the predictor is also helpful in obtaining label correlation. It is a common method in many researches.

3.4. MLL Classification Algorithms Based on Label Correlation. Although the correlation among labels plays an important role to MLL, some straightforward algorithms do not take it into account when dealing with multiple labels problems, i.e., the first order strategy. For example, the binary relevance algorithm on which many state-of-the-art algorithms are based and Label Powerset method in which each label set exists in the training dataset will be considered as a single label [14]. Here, we will review some classical algorithms based on label correlation to expound how to deal with multiple labels problems and how to use the correlation among labels.

3.4.1. Classifier Chain Algorithm. The basic idea of classifier chain algorithm is to converse MLL to a chain composed of some binary classifiers in which the precursor must be dependent on the successor to be established. First, set a sorting function $\pi(Y)$ to arrange all the labels in the label space in an ordered sequence $y_{\pi(1)} \prec y_{\pi(2)} \prec \cdots \prec y_{\pi(q)}$: in which $y_{\pi(1)} \prec y_{\pi(2)} \prec \cdots \prec y_{\pi(q)}$ represents $y_{\pi(i)}$ is prior to $y_{\pi(j)}$ and does not indicate the size relation between them. For a label $y_{\pi(j)}$ in an ordered sequence, a dichotomous classification training set corresponding to it is constructed as follows:

$$\mathfrak{D}_{\pi(j)} = \left\{ \left(\left[x_i, \mathrm{Pre}^i_{\pi(j)} \right], \varphi\left(Y_i, y_{\pi(j)} \right) \right) | 1 \le i \le m \right\}. \quad (3)$$

$\mathrm{Pre}^i_{\pi(j)}$ represents the relevance between all the precursor labels of $y_{\pi(j)}$ in an ordered sequence and x_i, that is,

$$\mathrm{Pre}^i_{\pi(j)} = \left(\varphi\left(Y_i, y_{\pi(1)} \right), \cdots \varphi\left(Y_i, y_{\pi(j-1)} \right) \right)^T. \quad (4)$$

After $\mathfrak{D}_{\pi(j)}$ is constructed, you can choose a traditional supervised learning algorithm $\mathfrak{B}(.)$ to train binary classifiers $h_{\pi(j)} \longleftarrow \mathfrak{B}(\mathfrak{D}_{\pi(j)})$. For a testing instance x, it traversal recursively the binary classifiers chain to determine whether a label $y_{\pi(j)}$ is assigned to x or not, and the predicted label set of x can be written as

$$Y = \left\{ y_{\pi(j)} \middle| h_{\pi(j)}(x) = 1, 1 \le j \le q \right\}. \quad (5)$$

The flowchart of the algorithm classifier chains is shown in Figure 4. If the output of binary classifiers $h_{\pi(j)}(x)$ is a real value, we need to symbol for it to judge whether the class labels corresponding to the value are the related labels of x or not.

The successor binary classifier of classifier chain algorithm relies on the precursor classifier, so the sort function $\pi(Y)$ is extremely critical. The ECC (ensemble of classifier chains) algorithm gives an efficient sorting method. Firstly, ECC constructs n sort functions $\pi^1(Y), \pi^2(Y), \cdots, \pi^n(Y)$ on class label space, and then for any sort function $\pi^j(Y)$, it generates a new dataset D^j by sampling from the original dataset D. Finally, for any $\pi^j(Y)$, a binary classifier chain is produced in corresponding D^j to integrate. For sampling without replacement, the size is generally 67% of the original dataset, while for sampling with replacement, it retains the same size as the original dataset. The algorithm is a high-order strategy, which has the advantage of taking into account about all the relations among labels; the disadvantage is that it is not suitable for parallel training on large-

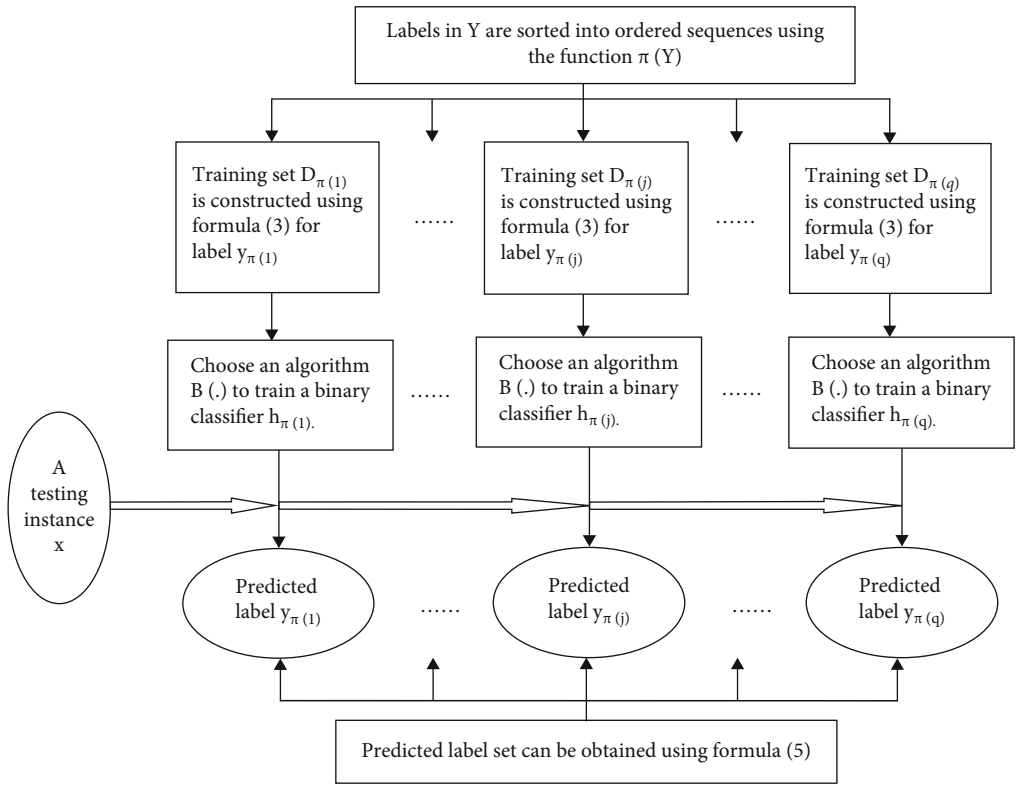

Figure 4: The flow chart of algorithm classifier chains.

scale datasets due to the successive relation in the chain. Additionally, the dimension of the data is also increasing with constantly iterating.

3.4.2. Calibrated Label Ranking. The idea of this algorithm is to convert MLL problems into label ranking problems by comparing each pair wise among labels. For the label space which scale is q, we need $q(q-1)/2$ label pairs in total to describe the one-one relationship among labels. For each label pair (y_j, y_k), construct a training set corresponding to it:

$$\mathfrak{D}_{jk} = \left\{ \left(x_i, \theta\left(Y_i, y_j, y_k \right) \right) \middle| \varphi\left(Y_i, y_j \right) \neq \varphi(Y_i, y_k), 1 \leq i \leq m \right\}, \tag{6}$$

in which

$$\theta(Y_i, , y_k) = \begin{cases} 1, & y_j \in Y_i \bigwedge y_k \notin Y_i, \\ -1, & y_k \in Y_i \bigwedge y_j \notin Y_i. \end{cases} \tag{7}$$

Thus, for each instance x_i, it would be resampled $|Y_i| * |\bar{Y}_i|$ times for training binary classifiers. And then, the algorithm selects a traditional binary classification algorithm $\mathfrak{B}(.)$ to train a binary classifier $h_{jk} \longleftarrow \mathfrak{B}(\mathfrak{D}_{jk})$. For instance, x the learning system will vote to y_j if $h_{jk}(x) > 0$; otherwise, vote to y_k. For a testing instance x, the algorithm calls $q(q-1)/2$ classifiers to vote for each label as follows:

$$V\left(x, y_j \right) = \sum_{k=1}^{j-1} \left[h_{kj}(x) \leq 0 \right] + \sum_{k=j+1}^{q} \left[h_{jk}(x) \geq 0 \right]. \tag{8}$$

In order to divide labels into two types of related and irrelated labels by voting, the algorithm set a virtual label y_v (do not care about its value) as a threshold and constructed q training sets corresponding to the label pair of y_v and $y_j (j \in [1, q])$:

$$\mathfrak{D}_{jv} = \left\{ \left(x_i, \varphi\left(Y_i, y_j \right) \right) \mid 1 \leq i \leq m \right\}. \tag{9}$$

Ibid., q binary classifiers were trained on $\mathfrak{D}_{\mathrm{jv}}$. Let y_v and y_j join the vote process, if the $h_{jv}(x) \geq 0$ that indicated y_j was at the front of the threshold, that is, relevant label. New voting function is updated to

$$V^*\left(x, y_j \right) = V\left(x, y_j \right) + \left[h_{jv}(x) \right] > 0. \tag{10}$$

The flowchart of the algorithm Calibrated Label Ranking is shown in Figure 5. The algorithm takes into account the relationship between each label pair and therefore belongs to the second-order strategy. Compared with the one-vs.-rest relationship, the one-vs.-one relationship that the algorithm considered to construct training set could alleviate the imbalance problem among labels. In addition, the

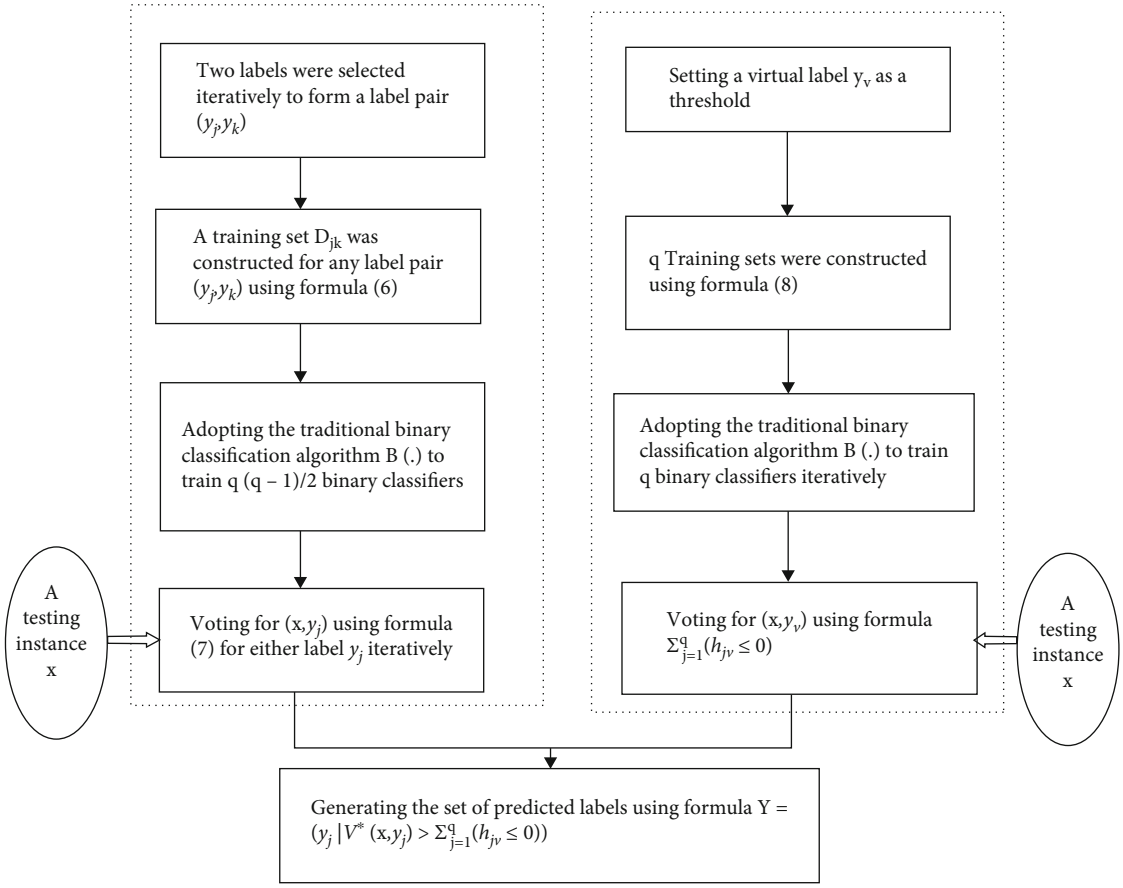

Figure 5: The flow chart of algorithm Calibrated Label Ranking.

number of constructed binary classifiers is upgraded to the secondary from the linear scale, so the algorithm could be improved by using the Pruning branch method in the testing phase [15].

3.4.3. Random k Label Sets. The idea of the method is to convert MLL into an ensemble learning problem based on multiclass. The basic classifiers in the ensemble learning randomly selected n label space subsets contained k labels by using LP (Label Powerset) technology (each subset as a class). Thus, it converted MLL to multiclass problems [16].

Assume the multiclass training set is $\mathfrak{D}_M = \{(x_i, \sigma(Y_i)) \mid 1 \le i \le m\}$. A multiclassifier $h(.) \longleftarrow \mathscr{M}(\mathfrak{D}_M)$ could be obtained by using a conventional multiclass learning algorithm $\mathscr{M}$. When the label space Y is very large, there would be too many label subsets in D, which would lead to high complexity. Random k label sets specified the scale of label subsets to be k, and randomly selected n subsets from (q/k) for learning. So the scale of label space in multiclass tasks is reduced from q to $k\,(k < q)$. For any label subset Y_j^k, construct a multiple class training set:

$$\mathfrak{D}_M{}^{Y_j^k} = \left\{ \left(x_i, \sigma\left(Y_i \cap Y_j^k \right) \right) \mid 1 \le i \le m \right\}. \tag{11}$$

Ibid., multiclassifier $h^{Y_j^k}(.) \longleftarrow \mathscr{M}(\mathfrak{D}_M{}^{Y_j^k})$ can be obtained. The algorithm randomly selected n multiclassifiers for ensemble learning. For any label $y_r (r \in [1, q])$ of a testing instance x, the max value max (y_r) that the ensemble learning system might vote for it and the actual value act (y_r) that the ensemble learning system actually voted for it were calculated as follows:

$$\begin{aligned} \max(x, y_r) &= \sum_{j=1}^{n} \left[y_r \in Y_j^k \right], \\ \operatorname{act}(x.y_r) &= \sum_{j=1}^{n} \left[y_r \in \sigma^{-1}\left(h^{Y_j^k}(x) \right) \right]. \end{aligned} \tag{12}$$

When act (y_r) reached half of max (y_r), y_r could be considered to be related to x, that is,

$$Y_x = \{>0.5\}. \tag{13}$$

Random k label set is a high-order strategy. The value of k in the algorithm controls the relevant range among labels, so there is a critical impact on the performance of the algorithm; the experience value of k is generally set to 3, while the number of base classifiers n preferably chose $2q$.

3.4.4. GLOCAL (Multilabel Learning with GLObal and loCAL Correlation). In practical applications of MLL, more complex situations may occur. For example, partial labels

of some instances are complete, while others may be missing. Since the given data distribution may be different from the ground truth distribution, learning the correlation among labels on such datasets is challenging [17]. In addition, global and local label correlation may exist simultaneously in the same application. For the two cases discussed above, the GLOCAL algorithm transforms the ground truth matrix $\tilde{Y}$ into a product of two matrices by the low-rank matrix decomposition, i.e., $\tilde{Y} = UV$ [18], where the matrix V represents a latent label matrix that is more concise and semantically more abstract than the original label matrix $\tilde{Y}$, while the matrix U is used to project $\tilde{Y}$ into the latent label space. Let Y denote the given label matric (possibly missing some labels) in training dataset D. The local correlations of labels can be obtained by dividing training dataset D into g-related subsets by domain knowledge or clustering. The GLOCAL algorithm alternately solves the missing labels, learns the linear classifier, and adopts both global and local label correlations by optimizing the following formula:

$$\min_{U,V,W} \|\Pi_{\Omega}(Y - UV)\|_F^2 + \lambda_1 \left\|V - W^T X\right\|_F^2 + \lambda_2 R(U, V, W) + \lambda_3 tr\left(F_0^T L_0 F_0\right) + \sum_{m=1}^{g} \lambda_4 tr\left(F_m^T L_m F_m\right), \tag{14}$$

where $\lambda_1, \lambda_2, \lambda_3, \lambda_4$ are tradeoff parameters; when the corresponding position of Y is a non-0 element, $\Pi_{\Omega}(Y - UV) = (Y - UV)$; otherwise, $\Pi_{\Omega}(Y - UV) = 0$. Matrix W is used to implement mapping instance matric X onto the latent label matrix V, which can be achieved by minimizing $\|V - W^T X\|_F^2$. $R(U, V, W)$ is the regular term part, used to regularize the model using label correlation; that is, the more the two labels are positively correlated, the closer the output value of the model is. Let $F_0 = UW^T X$. Suppose the global correlation matrix is marked as S_0, L_0 is the Laplacian matrix of S_0. For any training subset D_m, assuming that the local correlation matrix on it is S_m, then $F_m = UW^T X_m$, and L_m is the Laplacian matrix of S_m. The alternating optimization of U, V, W is performed by fixing two of them and optimizing the last one.

3.5. Challenging Issues about Label Correlation. Although the correlation among labels has attracted the interest of scholars in recent years, at least the following challenging issues need to be further explored. First of all, the correlation among labels has been approved, but the study on formal characterization on the concept or principled mechanism on appropriate usage of the concept is not yet sufficient so far. Some researches indicate that the correlation among labels might be asymmetric; i.e., the influence of label y_i to label y_j might not be valid on label y_j to label y_i. Furthermore, the correlation among labels might be local; i.e., there are seldom global correlations for all examples on the whole training dataset Secondly, the applicable conditions of the correlation among labels are not given enough consideration. How to use label correlation to improve the performance of MLL algorithm in specific fields still needs a lot of further exploration in experimental comparison. Thirdly, why label correlation can improve the performance of MLL and how it works have not been fully understood. The last but not the least, for large scale label space, how to reduce the computational complexity of the algorithm when the correlation among labels is complex (especially for high order strategy model). In other words, how to trade-off between expressing ability of label correlation and computational complexity. In addition, for all MLL algorithms (not just for that based on label correlation), the nature of training dataset (e.g., the completeness of label or noise data) has a great influence on the performance of MLL algorithms; and the class imbalance in MLL is another challenging topic [19].

4. Evaluation Metric

4.1. Common Evaluation Metrics and Related Theories. Since each instance is associated with multiple labels in MLL, the metrics for performance evaluation in MLL are more complex than those in binary classification [20]. In general, the common metrics for performance evaluation in MLL are subset accuracy, hamming loss, accuracy, one-error, coverage, ranking loss, average precision, macroaveraging, microaveraging, AUC-macro, AUC-micro, and so on.

To the best of our knowledge, existing MLL evaluation metrics often only reflect the generalization performance of MLL classifiers in some aspects, and no universal MLL evaluation metric has been found. Generally speaking, adopting metrics based on example is a good choice for classification tasks, while adopting metrics based on labels is a better choice for retrieval tasks. Cheng et al. showed that the Hamming loss and the subset could not be optimized simultaneously in 2010. When evaluating the performance of the algorithm on the test set, more metrics are chosen, and the evaluation effect should be fairer.

4.2. MLL Classification Algorithms Based on Evaluation Metrics. The MLL classification task is more complex, and the MLL evaluation metric is more challenging, so more recent studies have focused on this work. Different metrics often take care of algorithm performance from different aspects and reflect different natures. However, most MLL algorithms often only optimize one metric [21]. It should be said that different metrics are adopted for different MLL algorithms, and their generalization performances are also different. Gao et al. study the Bayes coherence of substitution loss in MLL and demonstrates that neither any convex substitution loss nor rank loss are coherent, proposing an alternative loss function for Hamming loss in specific context conditions [22].

Wu et al. analyzed the common properties of 11 MLL metrics mentioned above, proposed the concepts of instance-wise and label-wise based on margin, and gave a unified understanding about MLL:

$$\text{instance}_{\text{wise}} = \min_{a,b} \left\{ f_j(x_a) - f_j(x_b) \right\} \left(\left(a \in Y_{\bullet j}, b \in \overline{Y_{\bullet j}} \right) \right), \tag{15}$$

where $Y_{\bullet j}$ is the set of the positive instance index of y_j and $\overline{Y_{\bullet j}}$ is the set of the negative instance index of y_j.

$$\text{label}_{\text{wise}} = \min_{u,v}\{f_u(x_i) - f_v(x_i)\}\left(u \in Y_{i\bullet}, v \in \overline{Y_{i\bullet}}\right), \quad (16)$$

where $Y_{i\bullet}$ is the set of the relevant label index of x_i and $Y_{i\bullet}$ is the set of the irrelevant label index of x_i.

It was shown that the concepts based on margin can be used to optimize certain MLL metrics. The metrics that can be optimized were analyzed for ranking and classification, respectively, and the details are shown in Table 2.

Because double wise has the advantages of caring 11 metrics simultaneously, an algorithm for optimizing both instance-wise and label-wise is proposed, called the LIMO algorithm. Assuming $F = W$, the LIMO algorithm randomly assigns the weight matrix W an initial value of $W0$ that follows a normal distribution $(0, d)$, and the optimization model is solved by SGD (stochastic gradient descent):

$$\begin{aligned} \arg\min_{w,\xi} \quad & \sum_{i=1}^{q}\|w_i\|^2 + \lambda_1\sum_{i=1}^{m}\sum_{(u,v)}\xi_i^{uv} + \lambda_2\sum_{j=1}^{q}\sum_{(a,b)}\xi_{ab}^{j} \\ \text{s.t.} \quad & w_u^T x_i - w_v^T x_i > 1 - \xi_i^{uv}, \xi_i^{uv} \geq 0, \end{aligned} \quad (17)$$

for $i = 1, \cdots, m$ and $u \in Y_{i\bullet}, v \in \overline{Y_{i\bullet}}$

$$w_j^T x_a - w_j^T x_b > 1 - \xi_{ab}^{j}, , \xi_{ab}^{j} \geq 0, \quad (18)$$

for $j = 1, \cdots, q$ and $a \in Y_{\bullet j}, v \in \overline{Y_{\bullet j}}$

where ξ_i and ξ^j are two relaxation variables and λ_1 and λ_2 are two harmonic parameters used to adjust the instance-wise and label-wise; i.e., when $\lambda_1 = 0$, the LIMO algorithm optimizes instance-wise; when $\lambda_2 = 0$, the LIMO algorithm optimizes label-wise; when $\lambda_1 > 0$ and $\lambda_2 > 0$, the LIMO algorithm optimizes both instance-wise and label-wise. However, it is difficult to optimize both instance-wise and label-wise simultaneously in practice. An important contribution of LIMO algorithm is that it provides some reference for how to tradeoff between instance-wise and label-wise when they cannot be optimized at the same time.

5. Multilabel Semisupervised Learning

Traditional MLL is based on two fundamental assumptions: First, the sample in the training set has complete labels; second, the training set provides sufficient examples for the training process. However, in the practical application, annotating for multiple labels cost more than that for a single label. The correlation among unlabeled instances contains a wealth of useful information, which may contribute to reducing of the cost caused by multilabel classification and improving the classification performance [23, 24].

Multilabel semisupervised learning is an effective method that can make full use of these useful information. The training sets in multilabel semisupervised learning can be described as

Table 2: The details about MLL metrics optimized.

Metrics	instance_wise	label_wise	double_wise
Ranking loss	No	Yes	Yes
Average precision	No	Yes	Yes
One-error	No	Yes	Yes
Coverage	No	Yes	Yes
Instance-AUC	No	Yes	Yes
Macro-AUC	Yes	No	Yes
Micro-AUC	No	No	Yes
Macro-F1	Yes	No	Yes
Instance-F1	No	Yes	Yes
Micro-F1	No	Yes	Yes
Hamming loss	Yes	Yes	Yes

$$D = \{(x_1, Y_1), (x_2, Y_2), \cdots, (x_l, Y_l), (x_{l+1}, Y_{l+1}), \cdots, (x_p, Y_p), (x_{p+1}, Y_{p+1}), \cdots, (x_u, Y_u)\}, \quad (19)$$

in which $D_l\{(x_1, Y_1), (x_2, Y_2), \cdots, (x_l, Y_l)\}$ represents data with complete labels; $D_p = \{(x_{l+1}, Y_{l+1}), \cdots, (x_p, Y_p)\}$ indicate data with partial labels; and $D_u = \{(x_{p+1}, Y_{p+1}), \cdots, (x_u, Y_u)\}$ say the data with no label. The numbers of the elements which they contain are, respectively, $l = |D_l|, p = |D_p|, u = |D_u|$ and $l + p + u = m = |D|$. For easy description herein, D_p and D_u collectively refer to D_u.

The goal of the multilabel semisupervised learning is to model on a given training set and to predict the labels assigned to an unknown instance x by learning. If $x \in D_u$, that is, the testing instance is closed for the training set, this learning strategy is called transductive semisupervised learning; otherwise, known as inductive semisupervised learning. The typical transductive semisupervised learning includes Tram (Transductive multilabel classification) and DMMS (normalized dependence maximization multilabel semisupervised learning method). Tram is built on the following assumption: the labels related to an instance are smooth for the aspect of attribute manifold, and then, a MLL model like random walk can be obtained. While DMMS is built on the basis of the dependence of the statistical theory, take the labels in$D_l$as constraint. It estimates the normalized dependence to attribute set and label set on the entire dataset, and the optimization target is to maximum the estimated value of dependence. DMMS learning outcomes remained significant when the data D_l is sparse [25, 26].

It is worth mentioning that in the learning frameworks with unlabeled information to improve learning performance, active learning is an effective way, resulting in a set of learning frameworks called MLAL (multilabel active learning). Active learning submits some unlabeled data to the field experts for annotating in iteration ways according to some kind of inquiry criterion and then submits the labeled data to the training model to improve its generalization performance. The study focuses on how to filter the

typical instances to experts to annotate and, as much as possible, to reduce the number of labeling. Currently, active learning query criteria can be divided into two types, which are information content and representation. Information content (such as uncertainty and the degree of unity) describes the performance of the selected unlabeled instances in terms of reducing the uncertainty of learning model. Representation (such as density and cluster centers) describes the ability that the selected instances represent the overall data distribution. Huang et al. proposed AUDI (Active query driven by Uncertainty and Diversity for Incremental multilabel learning), QUIRE (Querying Informative and Representative Examples) which are a certain breakthrough on reducing the labeling cost by active learning using relationships between labels [27, 28].

AUDI constructs a classification model for any label y_j($j \in [1, q]$) in the label space:

$$f_j(x) = \omega_j^T W_0 x, \tag{20}$$

in which W_0 is the $q * d$ matrix, with the role of mapping the feature vectors (d dimension) in training set D_l to a low-dimensional (q dimensional) shared subspace, and ω_j^T is a q-dimensional weight vector, which corresponds to a linear model based on a shared subspace. For a x_i in D_l and a label $y_k (y_k \in Y_i)$ assigned to x_i, define an error of ranking:

$$\epsilon(x_i, y_k) = \sum_{j=1}^{R(x_i, y_k)} \frac{1}{j}, \tag{21}$$

in which $R(x_i, y_k)$ indicates the number of the misarranged labels with y_k as a center, that is, the number of the unrelated labels before y_k. The purpose of learning is to minimize ϵ(x_i, y_k) on the entire training set. However, this objective function is a nonconvex function. In order to facilitate optimization, AUDI selected the hamming loss as an approximate alternative loss function:

$$\epsilon(x_i, y_k) \le \sum_{\bar{y} \in \bar{Y}} \epsilon(x_i, y_k) \frac{\max\left(0, 1 + f_{\bar{y}}(x_i) - f_y(x_i)\right)}{R(x_i, y_k)}. \tag{22}$$

In fact, the wrong order on x_i may also be considered as the sum of the irrelevant labels before the relevant label y_k. So it can be decomposed into each $\bar{y} \in \bar{Y}$ to get

$$L(x_i, y_k, \bar{y}_w) = \epsilon(x_i, y_k) \max\left(0, 1 + f_{\bar{y}_w}(x_i) - f_{y_k}(x_i)\right). \tag{23}$$

Using the stochastic gradient descent method to solve the objective function, we can obtain classification model.

After the model being obtained, it predicted for all instances in D_u, and AUDI wants to select the most valuable instances from them to give the experts in the fields to annotate. The most valuable points are reflected in two aspects: First, the instance contains most information which is used to distinguish uncertainty whether or not being related; second, the diversity is the biggest between the selected instance and the previously queried instances. It is the typical representative of the unselected instances. That is,

$$C_1(x_i) = \frac{\left|\sum_{k=1}^{q} I[\hat{y}_{ik} > 0] - (1/l)\sum_{j=1}^{l}\sum_{k=1}^{q} I\left[y_{jk} > 0\right]\right|}{\max\left(0.5, q - |U(x_i)|\right)}, \tag{24}$$

in which $\left|\sum_{k=1}^{q} I[\hat{y}_{ik} > 0] - (1/l)\sum_{j=1}^{l}\sum_{k=1}^{q} I[y_{jk} > 0]\right|$ describes the disunity of label set cardinality (LCI) and represents the difference between the number of related labels that the model output and the average number of ground truth-related labels in D_l. $I[\bullet]$ represents a indicator function. U(x_i) represents the label set with no query assigned to x_i.

Suppose the most valuable instances selected by (24) are x^*, and AUDI queried the most valuable label once for every time to the labels of x^*; AUDI screens the most valuable label of x^* using the following formula:

$$C_2(x_i) = \left|f_y(x^*) - f_{y_v}(x^*)\right|. \tag{25}$$

Here, y_v stands for the virtual label between relevant and irrelevant label. y^* which makes $C_2(x_i)$ minimum is the most valuable label.

AUDI obtains a predicting model with the labeled training set firstly, and each round filters a most valuable instance-label pair based on the predicated value of the model to the experts of field to annotate. The model filters out redundant labels in the maximum extent using the relationship between the labels, and therefore, it belongs to using the relationship between the labels indirectly. When screening instance-label pair, it takes overall consideration of the two factors: amount of information and representation, which reduces the query cost substantially and enhances the classification performance. But the amount of information and representation is connected with each other in a fixed way, and this way may be less flexible in certain applications.

QUIRE trains a classifier $f_j, j \in [1, q]$ for each label on the labeled dataset D_l, and the predicted value that f_j output for each instance consists of a predicted vector f_j on the label, and predicted vectors for all labels form a predicted matrix $F = \{f_j \mid 1 \le j \le q\}$. Calculating nuclear matrix Kon the entire dataset, entering the relation matrix between labels R, and objective function could be defined as

$$\min_{F \in R^{m*q}} \lambda tr\left(R^{-1} F^T K^{-1} F\right) + |F - Y|_2^2, \tag{26}$$

in which $tr(\cdot)$ is the matrix trace function and Y is a ground-truth label matrix of all examples. Based on min–max view framework, the optimal solution is obtained. On this basis, QUIRE defines a matrix L based on R, K, which is used to select guidelines which contributes to selecting the most

valuable example-label pair:

$$L = \lambda[R \bigotimes K + \lambda I]^{-1}. \quad (27)$$

$\bigotimes$ is the tensor product of the matrix.

Because L is defined on D_l and D_u (the entire training set), the predicted confidence for the selected instances to be queried using D_l cloud reflect the factor of amount of information; for D_u, if the selected instance is very representative it should be highly similar to other instances, and if labels conform to uniform distribution, lots of unlabeled instances in D_u will result in a lower degree of confidence. And therefore QUIRE can choose the most valuable instance-label pair by minimizing both the confidences. The matrix L constructed on R and K contains two relationships: the relationship between labels and the relationship between instances, and the two factors, the amount of information and co-ordinate representation, are overall planed.

The QUIRE method makes use of the label relations directly in the algorithm, and reduces the number of computing inverse matrix when solving unlabeled instance–label and is suitable for processing massive tasks with more unlabeled instances. However, the QUIRE method requires the relationship between the labels in D_l as the known knowledge to input to algorithm, and regards the labels in D_u lines with uniform distribution.

Relations between the labels play a key role in multilabel active learning tasks. When submitting a query to experts in the field, the type of query and the exploit of the relationship between the labels in D_l are equally important. Huang et al. firstly proposed a new multilabel active learning framework AURO to query correlation order between the label pair, which requires experts in the field to mark the importance of the correlation between labels [29]. Different with the traditional multilabel active learning, AURO submits the query information to unlabeled instances to the staff in the form alternative versions. Suppose y_i, y_j correspond to the two labels to be queried of the instance x_u, and design the options as follows: (1) for instance x_u, y_i is more relevant than y_j; (2) for instance x_u, y_i is not more relevant than y_j; and (3) for instance x_u, y_i and y_j are not relevant. With the simple selection strategy and sequence label model, the framework helps annotator with less professional knowledge to obtain more label information. The framework opens up a new perspective of multilabel active learning, which gives the researchers a good way to design and explore more extensive query options to exploit the relationship between the labels, or in conjunction with a better selection strategy to achieve better classification performance. Compared with the traditional multilabel active learning algorithm, the time cost on label annotation is reasonable, but the original frame on option design is simpler; for example, the similar relevant cases of the two labels are not considered.

The notable feature of the multilabel active learning requires human-computer interaction. In multilabel semisupervised learning methods which do not require human-computer interaction, the inductive semisupervised learning method has better generalization performance. Compared with a transductive method, it can naturally predict unknown instances outside the testing set. Currently, the amount of researches on inductive semisupervised learning is relatively small. Taking traditional empirical risk minimization principle as theoretical guarantee, Li et al. first proposed inductive semisupervised learning method MASS (multilabel semisupervised learning) aimed at MLL. Similar with a traditional multilabel learning algorithm, MASS assumes that decision function is resolved to each label $F = \{f_1, f_2, \cdots, f_q\}$ and assumes that the decision function f_j on each label is a linear model, namely, $f_j(x) = <\omega_j, \phi(x)>$, in which $\phi(x)$ stands for the attribute mapping function derived by the kernel function and $<\bullet, \bullet>$ stands for the inner product in reproducing kernel Hilbert space H spanned by the kernel function. It is need to guarantee theoretically the vector F combined of f_j belongs to the reproducing kernel Hilbert space which is signed as H_v. The objective function is solved by MASS:

$$F^* = \arg \min_{F \in H_v} \frac{1}{l * q} \sum_{i=1}^{l} V(x_i, Y_i, F) + \frac{r_s}{q} \Omega(F) + \frac{r_a}{(l+m)^2 q^2} I(F). \quad (28)$$

l is the labeled data scale; m is the total size of the training set; q is the size of labeled space; $V(x_i, Y_i, F)$ represents empirical risk on datasets. Similar with classic MLL algorithms, MASS chosen hamming loss function to measure it, namely,

$$V(x_i, Y_i, F) = \sum_{j=1}^{q} l\left(x_i, Y_{ij}, f_j\right). \quad (29)$$

$l(\bullet)$ was the hinge loss function in SVM; $\Omega(F)$ was a regular item used to control the complexity of F; $I(F)$ was a manifold regular item used to constrain that "similar instances have similar multilabels with structure"; r_s and r_a were two coefficients used to make a trade-off between the importance of the two regular items, respectively. MASS defined the regular item $\Omega(F)$ as follows:

$$\Omega(F) = \mu \|\omega_0\|^2 + \frac{\sum_{j=1}^{q} \|\omega_j\|^2}{q}, \quad (30)$$

in which $\omega_0 = (1/q)\sum_{j=1}^{q} \omega_j$, μ was a regularization coefficient in $[-1, 0]$ used to adjust the force of the before and after items. $\|\omega_0\|^2$ reflected the common property, while $\sum_{j=1}^{q} \|\omega_j\|^2$ reflected the unique properties of the j^{th} label. When $\mu = -1$ minimizing the formula (30) would drive ω_j of all the labels to be consistent. Instead, when $\mu = 0$, minimizing the formula (30) would drive ω_j of all the labels to be independent.

MASS defined the regular item $I(F)$ as follows:

$$I(F) = \sum_{i,j=1}^{m} \left(F(x_i) - F(x_j)\right)^T B^{-1} \left(F(x_i) - F(x_j)\right) W_{ij}, \quad (31)$$

in which $B = P^T * P$, P was a $q * q$ projection matrix which projected label space into a new space that could describe the difference among multi labels. And W was a $m * m$ similarity matrix which described the similarity among the instances. As for the matrix B used to describe the relation among labels, MASS gave two solving ways: one was given by the domain knowledge; the other was learned from D_l and D_u by alternating optimization techniques.

Wu et al. used the relation among the labels in D_l and the accuracy degree inferring unlabeled instances in D_u to model the learning progress and provided a novel inductive multilabel semisupervised learning algorithm iMLCU (inductive Multilabel Classification with Unlabeled data) [30]. iMLCU assumed multilabel classification model was combined by q linear classifiers; each label $y_j (j \in [1, q])$ in the label space corresponded to a linear classifier $f_j(x, y_j) = \omega_j{}^T x + b_j$, in which ω_j was is a d dimensional real valued weight vector, b_j was a real valued bias, and marked $W = \{(\omega_j, b_j) \mid 1 \le j \le q\}$. For an unknown instance x, the classifier predicted its label was

$$\hat{Y} = \operatorname{sign}\left(f_1(x, y_1), \cdots, f_q\left(x, y_q\right)\right) = \operatorname{sign}\left(\left(\omega_1^T x + b_1\right), \cdots, \left(\omega_q^T x + \mathrm{b}_q\right)\right). \quad (32)$$

And then we utilized the relation between the data in D_l and D_u to obtain an optimal W that made the formula (32) to predicate a more accurate value for the new unknown instance. Firstly, let us consider the labeled data, for any example (x_i, Y_i) in $D_l, y_j \in Y_i$ was a related label assigned to x_i, and $y_k \in \bar{Y}_i$ was an irrelated label assigned to x_i. Considering the relevance ranking among the labels, the decision boundary between related and irrelated label of x_i could be defined by the hyperplane between y_j and y_k, that was $(\omega_j - \omega_k)^T x_i + b_j - b_k$. Taking maximum metric hypothesis as the theoretical guarantee in the labeled dataset D_l, the objective function can be obtained:

$$\min_{W,\Xi} \quad \sum_{j=1}^{q} \left\|\omega_j\right\|^2 + C \sum_{i=1}^{l} \frac{1}{\left|Y_i\right|\left|\bar{Y}_i\right|} \sum_{y_j \in Y_i, y_k \in \bar{Y}_i} \xi_{ijk} \quad (33)$$

$$\text{s.t.} \quad \left(\omega_j - \omega_k\right)^T x_i + b_j - b_k \ge 1 - \xi_{ijk}, \quad (34)$$

$$\xi_{ijk} \ge 0 \left(i \in [1, l], \left(y_j, y_k\right) \in Y_i \times \bar{Y}_i\right), \quad (35)$$

in which $\Xi = \{\xi_{ijk} \mid (i \in [1, l], (y_j, y_k) \in Y_i \times \bar{Y}_i\}$. The two items in formula (35) were used to control model complexity and empirical loss in D_l respectively, and the constant term C was used to make a trade-off between them.

And then think about unlabeled data. For the unlabeled data in D_u, we still expect the predicted labels by using classification model can be farther away from the boundary and the misclassified instances should be punished. The difficulty for achieving this expectation lies in how to know the ground-truth labels of the data in learning process. Therefore, we cannot directly give the predicted labels some reward or punishment. For this goal, S3VM provides an idea for reference: borrowing hinge loss function.

For any unlabeled instance, the predicted labels through the previous way just only were considered putative labels but not official predicted labels. In addition, we use hinge loss function to punish the loss for putative labels.

$$c_j\left(x, f_j\left(x, y_j\right)\right) = \max\left(1 - \operatorname{sign}\left(\omega_j{}^T x + b_j\right)\omega_j{}^T x + b_j, 0\right) = \max\left(1 - \left|\omega_j{}^T x + b_j\right|, 0\right). \quad (36)$$

And then minimized penalty function in formula (36) on all labels of all the instances in D_u, combing with formula (35), the optimization function can be obtained:

$$\min_{W,\Xi} \quad \sum_{j=1}^{q} \left\|\omega_j\right\|^2 + C_1 \sum_{i=1}^{l} \frac{1}{\left|Y_i\right|\left|\bar{Y}_i\right|} \sum_{y_j \in Y_i, y_k \in \bar{Y}_i} \xi_{ijk} + C_2 \sum_{i=l+1}^{l+u} \sum_{j=1}^{q} \max\left(1 - \left|\omega_j{}^T x_i + b_j, 0\right|\right) \quad (37)$$

$$\text{s.t.} \quad \left(\omega_j - \omega_k\right)^T x_i + b_j - b_k \ge 1 - \xi_{ijk}, \quad (38)$$

$$\xi_{ijk} \ge 0 \left(i \in [1, l], \left(y_j, y_k\right) \in Y_i \times \bar{Y}_i\right), \quad (39)$$

$$\frac{1}{u} \sum_{i=l+1}^{l+u} \left(\omega_j{}^T x_i + b_j\right) = \frac{1}{l} \sum_{i=1}^{l} y_{ij}. \quad (40)$$

Comparing formula (40) with formula (35), there is an additional regular item in formula (40), that is, the total loss function used to constrain all the labels of all instances in D_u. In addition, compared with formula (35), the formula (40) also contains another constraint, that is, $(1/u)\sum_{i=l+1}^{l+u}(\omega_j{}^T x_i + b_j) = (1/l)\sum_{i=1}^{l} y_{ij}$ which is used to ensure that the predicted label diversity in D_u is consistent with those in D_l. iMLCU takes two parameters C_1 and C_2 to weigh the loss over D_u and D_l. It will encounter a problem for direct optimize the formula (34): it is nonconvex function. Hence, iMLCU uses ConCave Convex Procedure (CCCP) to solve the globally optimal solution of the nonconvex function.

iMLCU tries to maximize the metric between relevant label and irrelevant label, so it belongs to the second order learning strategies.

For multilabel semisupervised learning, some researchers proposed S3VM (Semisupervised Support Vector Machine) and graph-based semisupervised learning methods. S3VM was based on the basic assumption of low-density separation; try to learn a classification hyperplane which can separate two kinds of examples and be able to pass through the low-density regions [31]. There are a series of S3VMs achievements on reducing the computational complexity, but many of these approaches do not take

full advantage of the correlation among labels. TSVM (Transductive Support Vector Machine) is the most famous one among them. For the problem that there are some harmful unlabeled instances in S3VMs training set which would reduce instead of improve the performance of the classifier, Li et al. proposed a more secure S4VMs that used a plurality of low-density slicer to approximate ground-truth boundary. It maximized the performance of the algorithm in the protection of algorithm safety. Semisupervised learning algorithms based on graph once attracted the interest of many researchers. The basic idea of them is to construct a graph by taking a labeled data in D_l and an unlabeled data in D_u as a node in the graph; then estimate a function on the basis of this. This function must meet two conditions: First, the dataset has been labeled with the existing labels coincide; the second is that it should be smooth enough in the entire graph. The difference between the various algorithms based on graph is the defining on the estimated function. Graph-based concept is very clear, but its large storage is overhead and difficult to use on large-scale data [32, 33].

6. Label Distribution Learning

Traditional multilabel learning assumes that the importance of all the related (or irrelated) labels to the instance is similar; however, label distribution learning is to dispose of the learning task in which the importance of the labels to the instance is different from each other. For example, facial expressions might contain a lot of basic expressions such as "joy" and "emotional," but the description degree of each basic expression is very different. These learning tasks could not be finished based on the traditional MLL framework [34].

LDL defines $d_x^y \in [0, 1]$ that represents the description degree of the label y to instance x and assumes that the description degree of all the labels is complete, that is, $\sum_y d_x^y = 1$. The description degree of all the labels assigned to x is composed of a data formation in the form of probability distributions, so it is called label distribution; the learning process by the label distribution on the given dataset is called label distribution learning. In many applications, the description degree or correlation of the labels assigned to an instance x might not be same; however, the traditional MLL could only to express related relation (marked 1) or irrelated relation (marked 0); therefore, LDL is superior to MLL in general in many practical applications.

Compared with MLL, each instance in LDL datasets is assigned to one distribution about a label, instead of one label (or one label set). And the label distribution comes from nature feature of initial data in the application. Many MLL algorithms divide labels into two parts: related and irrelated labels, by label ranking based on certain threshold value. This method is only concerned with label sequence that can be distinguished but does not care about value as long as it is a specific predicted value. Instead, LDL cares for the overall distribution, each predicted value to the description degree is very important. Due to the different learning process, LDL performance assessment criteria are different from MLL. LDL measures performance of its algorithms by calculating the similarity between predicted distribution and ground-truth distribution on labels [34].

Suppose $D = \{(x_1, d_{x_1}), (x_2, d_{x_2}), \cdots, (x_m, d_{x_m})\}$ represents the training set, in which $d_{x_i} = \{d_{x_i}^{y_j} \mid 1 \le j \le q\}$ represents the distribution of labels assigned to x_i, the goal of LDL is to learn (or train) a conditional probability mass function $p(y \mid x; \theta)$ in which θ is a parameter, so that $p(y \mid x; \theta)$ is as similar as possible to the ground-truth distribution of labels d_x. LDL using KL divergence as a similarity criterion between predicted distribution and ground-truth distribution on labels, the goal of LDL can be transformed into the following optimization problem:

$$\theta^* = \arg\min_{\theta} \sum_i \sum_j \left(d_{x_i}^{y_j} \ln \frac{d_{x_i}^{y_j}}{p\left(y_j \mid x_i; \theta\right)} \right) = \arg \max_{\theta} \sum_i \sum_j p\left(y_j \mid x_i; \theta\right). \tag{41}$$

A variety of learning algorithms can solve the above optimization problem. For example, (x_i, d_{x_i}) can be split into q single-labels $(x_i, y_j)(i \in [1, m], j \in [1, q])$ whose weight is $D_{x_i}^{y_j}$, so PT-Bayes used posterior probability which is calculated based on Bayes theorem on the resampled standard single-label datasets as a predicted distribution of an unknown instance; PT-SVM used SVM to solve a single label learning task. It calculated output probability of SVM on each label, through Platt posterior probability [35–36]. The framework of these two algorithms is shown in Figure 6.

In addition to resampling on datasets, directly improved traditional algorithms can also handle the above optimization problem, typical algorithms such as AA-kNN and AA-BP. AA-kNN was a lazy learning algorithm, it did not find its k-nearest neighbors in the training set until an unknown instance x arrived and used the mean of label distribution of its k neighbors as the label distribution of x, that is,

$$p\left(y_j \mid x\right) = \frac{1}{k} \sum_{x_i \in N_k(x)} d_{x_i}^{y_j}, \tag{42}$$

in which $N_k(x)$ represents the k neighbor set of x and $j \in [1, q]$.

The AA-BP algorithm used the feature of x as the input of BP neural network and used the distribution of each label as output. The output value of AA-BP was adjusted to the real value belonged to [0,1] and satisfied the constraint that the sum of all the label distribution equaled 1. And then minimizing the sum of squared errors between output values and the ground-truth distribution of labels was used as the optimization goal to train neural network.

Both resampling on datasets and improved strategies on traditional algorithms transform LDL into MLL or SLL learning task; some researchers attempt to directly solve the optimization problem in formula (41). The representative algorithms are IIS-LLD and SA-BFGS [37].

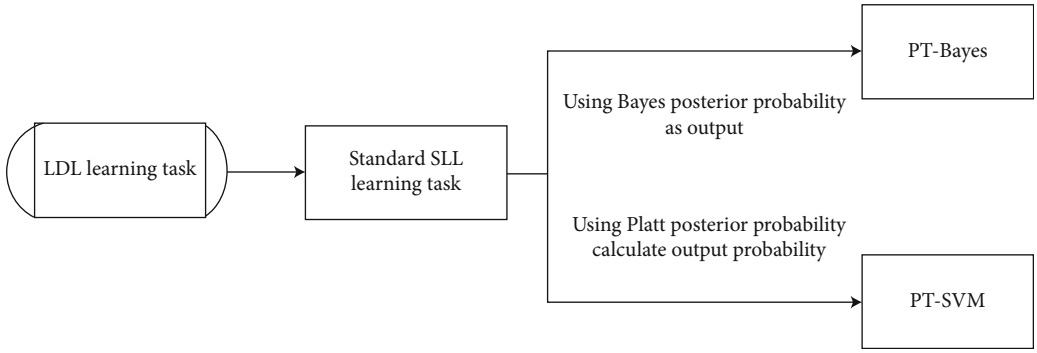

Figure 6: The framework of PT-Bayes algorithm and PT-SVM algorithm.

ISS-LLD supposed $p(y|X;\theta)$ model was the maximum entropy model $(y \mid x;\theta) = (1/Z)\exp(\sum_k \theta_{y,k} g_k(x))$, in which Z was a normalization factor, $\theta_{y,k}$ was a element of vector θ, and $g_k(x)$ was the k^{th} feature of x. Thereby, the optimization problem in formula (41) was transformed to

$$T(\theta) = \sum_{i,j} d_{x_i}^{y_j} \sum_k g_k(x_i) - \sum_i \ln \sum_j \exp\left(\sum_k \theta_{y_j,k} g_k(x_i)\right). \quad (43)$$

The optimization process in formula (43) used the thought (or idea, formulation) of IIS (Improved Iterative Scanning) that was θ which would be updated to $+\Delta$, $T(\theta)$ would be updated to $T(\theta+\Delta)$ in each round; until $T(\theta+\Delta) - T(\theta)$ would be stabilized in a smaller range.

A literature confirmed that the optimize process of IIS-LLD algorithm was ineffective. SA-BFGS improved the aforementioned optimization process by BFGS Quasi-Newton method [38]. SA-BFGS expanded formula (43) into second-order Taylor expansion at $\theta^{(l)}$ of l^{th} round, obtaining

$$T'\left(\theta^{(l+1)}\right) \approx T'\left(\theta^{(l)}\right) + \nabla T'\left(\theta^{(l)}\right)^T \Delta + \frac{1}{2}\Delta^T H\left(\theta^{(l)}\right)\Delta, \quad (44)$$

in which $\Delta = \theta^{(l+1)} - \theta^{(l)}$. $\nabla T'(\theta^{(l)})$ and $H(\theta^{(l)})$ were gradient and Hansen matrix of $T'(\theta)$ at $\theta^{(l)}$, respectively.

Therefore, the minimum value of formula (44) can be obtained as follows:

$$\Delta^{(l)} = -H^{-1}\left(\theta^{(l)}\right)\nabla T'\left(\theta^{(l)}\right). \quad (45)$$

SA-BFGS took $\Delta^{(l)}$ as a linear search direction by Newton method:

$$\theta^{(l+1)} = \theta^{(l)} + \lambda\Delta^{(l)}, \quad (46)$$

in which λ was step length. Due to the large computational cost when solving inverse Hansen matrix, SA-BFGS selected its approximate matrix B as a substitution. B was initialized to a random value, with each iteration as follows:

$$B^{(l+1)} = \left(I - \rho^{(l)} s^{(l)}\left(u^{(l)}\right)^T\right) B^{(l)} \left(\rho^{(l)} u^{(l)}\left(s^{(l)}\right)^T\right) + \rho^{(l)} s^{(l)}\left(s^{(l)}\right)^T, \quad (47)$$

in which $\nabla T'(\theta^{(l+1)})$ could be obtained by solving the partial derivatives of $\theta_{y_j,k}$ in formula (43).

The parameter vector $\theta^{(l+1)}$ in next round can be obtained by bringing $\nabla T'(\theta^{(l+1)})$ and $B^{(l+1)}$ into formula (45) and (46). Repeated the above-described process until $\nabla T'(\theta^{(l)})$ was convergent.

There are some other novel LDL algorithms in real application recently. COS-LDL uses a distance mapping function during training to exploit the correlation between labels and then yields the objective function. Similarly, LDL-SCL is another LDL algorithm that utilizes label correlations locally. LDL-SCL designs a distance-mapping function to map the label correlation to a distance, and then measures the similarity between labels using the distance [39]. LDL-LRR adapts the ranking loss function applying the cross-entropy and uses two metrics—Spearman's rank and Kendall tau correlation coefficient as the similarity metrics, to obtain the objective function. The improved LDL-LRR algorithm reflects the correlation distribution of either label y_i assigned to instance x; meanwhile, it reflects the relevance intensities of each related label-pairs (y_i, y_j) and enriches the expression abilities of the LDL model. ENN-LDL calculates the dominant labels in the training set D through hyperparameters δ and then divides the training set into k training subsets according to the dominant labels [40]. A weak classifier is trained on each training subsets based on the neural network rather than the maximum information entropy. Finally, these weak classifiers are combined with weight to become an integrated classifier using ensemble learning. ENN-LDL uses local correlation between labels in the proceeding of dividing the training set with the dominant labels. On the other hand, the division changes the original distribution of the training set, so the weak classifiers trained on the subset will be bias for unknown test examples. LDLFS consists of a set of differentiable decision trees, each one consisting of a series of split nodes and leaf nodes. The split nodes are used to distinguish whether current instance should be divided into left or right subtree,

and the leaf nodes are used to represent labels distribution of current instance. Each decision tree is obtained by defining a distribution-based loss function, which uses the Kullback-Leibler divergence (K-L) between ground-truth label distribution and the label distribution predicted by decision trees. The mean of loss function in all decision trees is taken as the loss function value of forest, and the split nodes from different decision trees are allowed to be connected to the same output node in a fully connected form, so that the parameters in the split nodes can be obtained by joint-learning in the form of backpropagation. In the optimization phase, minimizing the loss function of the forest is converted to iteratively reduce its upper bound. It is worth mentioning that although LDLFS is built based on traditional machine learning models, it can still be used in deep learning models with its fully-connected architecture [41].

Since the type of output in LDL is different from those of SLL and MLL, the evaluation criteria between them is also different correspondingly. The evaluation criteria of LDL algorithms are mainly based on distance or similarity. Currently, the mainstream method is to calculate the mean of distance or similarity between ground-truth distribution and predicted distribution. Thus, the criteria of distance or similarity in probability distribution could be introduced to LDL, such as Chebyshev distance, Clark distance, KL divergence, and cosine coefficients. 41 kinds of distance (or similarity) criterion are compared by computing in 30 independent experiments.

LDL provides a universal learning framework for classification, which could meet more demand in practical applications. For example, when some labeling experts have different views on the same instance, LDL could easily solve these problems by setting different description degree on the label assigned to the instance. In addition, LDL could generate a label distribution by utilizing the correlation among labels. Consequently, LDL has opened up a new way to enrich the MLL learning theory.

7. Conclusions and Discussion

Multilabel learning has attracted great interests among researchers in the fields of machine learning and data mining because it can describe richer class information in the output space and brings new challenges as the dimension of the label space increases. In recent years, many outstanding achievements have been made in supporting theories and improving algorithms in top international conferences and journals. Many mature algorithms or learning frameworks are applied to practical applications. This paper briefly discusses four major research hotspots in MLL: correlation among labels, evaluation metric, multilabel semisupervised learning, and label distribution learning (LDL) from a theoretical and algorithmic perspective, which might be useful in conducting further research by scholars interested in MLL.

The contribution of this paper is mainly reflected in four aspects. Firstly, although the current working principle of label association and how to find it in practical applications still lacks sufficient theoretical support, many scholars have done a lot of work on it. Based on this work, this paper discusses the categories of label correlations, analyzes why label correlations work, gives four methods on how to obtain the interlabel correlations, reviews some classic MLL algorithms, and points out several challenging issues about label correlations. Secondly, the evaluation metrics of MLL is more complex than that of single-label classification. Different MLL algorithms using different metrics have different generalization performance. This paper analyzes theories and representative algorithms related to MLL evaluation metrics. Thirdly, in practical MLL applications, there are many unlabeled instances due to their labeling cost. Multilabel semisupervised learning provides a solution for such problems. A summary of its advanced algorithms is given according to transductive and inductive categories, respectively. Fourthly, the LDL framework can describe the importance of each label to an instance in output space. The paper discusses the relationship between LDL and traditional MLL framework as well as formulaic paradigm of LDL.

Due to space constraints, this paper does not cover all areas of research in multilabel learning (which is not possible). For example, semisupervised learning is not fully discussed, and many representative algorithms are not discussed. It is empirical that the problem of missing labels or incorrect labels in MLL can greatly affect its classification performance and such related issues can be more sufficiently discussed in the future. In contrast to binary classification, the imbalance in MLL is reflected in at least two aspects: (1) the imbalance in the number of instances contained within different classes and (2) the imbalance between class labels. The class imbalance problem in MLL is more difficult to address, especially for extreme imbalance. Therefore, we hope that more research work will emerge in this area in the future. In addition, combining the MLL framework with other techniques may achieve better results, such as using deep learning techniques to solve some MLL problems, or using MLL methods in knowledge graph.

Although the algorithms covered in this article all attempt to design the original algorithms as general-purpose algorithms that can be broadly applied, each tends to be biased towards the data according to the No Free Lunch (NFL) principle. Where do these MLL algorithms, including representative algorithms mentioned above, play the best performance? There are still many experiments to be done in a future work, which is also a work worthy of further exploration.

Data Availability

The datasets used during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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Retraction

Retracted: Analysis of Digital Economy Development Based on AHP-Entropy Weight Method

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] S. Yang and J. He, "Analysis of Digital Economy Development Based on AHP-Entropy Weight Method," *Journal of Sensors*, vol. 2022, Article ID 7642682, 8 pages, 2022.

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Research Article

Analysis of Digital Economy Development Based on AHP-Entropy Weight Method

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At present, China's economic development is in a critical period of transformation, which needs to get rid of the dependence on the real estate industry and low-end export processing industry, and is in urgent need of new growth engines. The emergence of the digital economy has provided a boost to economic upgrading, but to give full play to the potential of the digital economy, we must have an accurate and full understanding of it. At present, the development of digital economy has become the focus of all circles. Digital economy is a multilevel and complex concept, so this paper establishes a multi-index comprehensive evaluation system and uses AHP-entropy weight method to measure the development level of China's digital economy and, on this basis, analyzes the development level, dynamic changes, and regional differences of China's digital economy. The results show that China's digital economy is on the rise, which is mainly driven by the construction of digital infrastructure and the application of digital technology. By region, there is a big gap between different regions in the development of digital economy, and this gap is expanding continuously. The digital economy in the eastern region is in a leading position, but only in the development of the digital industry.

1. Introduction

Since the 21st century, China's digital economy has developed vigorously. According to the White Paper on The Development of China's Digital Economy, China's total digital economy has risen from 22.6 trillion yuan in 2016 to 39.2 trillion yuan in 2020, and its share in GDP has also risen from 30.3 percent to 38.6 percent. With the emergence of a new generation of Internet technology, the development of digital economy has been further, creating huge economic benefits in a short period of time. Digital industry giants such as Alibaba, Google, and Tencent have emerged in various parts of the world, and digital economy has also occupied a pivotal position in the world economy [1]. At the same time, digital economy has gradually shown excellent driving force of economic development since the concept was put forward. With the in-depth application of digital technology and data elements in the production and operation of enterprises, the vitality of microeconomic subjects has been significantly enhanced. For example, digital simulation and scene simulation based on virtual algorithm can realize the testing process that originally needs a lot of money and materials in the computer, reducing the cost of trial and error [2, 3]. The more convenient information interaction capability in digital economy enables enterprises to quickly capture users' recognition of existing products with the help of big data and Internet technology, discover users' core and potential needs, and promote enterprises to carry out targeted innovation [4]. This shows that digital economy is not only a major component of China's economy but also an important lever to promote high-quality economic development. A detailed and accurate understanding of the development status of digital economy is the fundamental premise to make full use of the development dividend of digital economy and promote high-quality economic development. Therefore, it is of rich theoretical and practical significance to calculate and analyze the current development of digital economy.

At present, the definition of digital economy in the academic circle can be roughly divided into narrow sense and broad sense: the narrow sense of digital economy mainly includes digital industry, that is, information communication

Table 1: 1-9 scale method.

Scale	Meaning
1	The two factors are equally important
3	Comparing the two factors, the former is slightly important
5	Comparing the two factors, the former is more important
7	Comparing the two factors, the former is very important
9	Comparing the two factors, the former is absolutely important
2, 4, 6, and 8 are the intermediate values	

industry and e-commerce industry as well as the infrastructure supporting the digital industry, while the broad sense of digital economy also includes organizational and social economic changes caused by the application of digital technology and data elements [5]. It is obvious that, in a broad sense, the digital economy is no longer limited to specific industries such as computer and Internet commerce but transformed into a new economic model. Therefore, digital economy is defined in this paper as digital industry, infrastructure supporting digital industry, and digital improvement of traditional industry by using data elements and digital technology. It is a new economic form based on digital industry such as information technology industry and characterized by integration with traditional industry.

Existing research has a preliminary understanding of the development of digital economy. Liu et al., Cai and Niu, and Han et al. respectively established a digital economy scale accounting framework, respectively measured the added value and total output value of China's digital economy, and obtained the consensus that China's digital economy has been developing at a high speed in the past decade [6–8]. Xu and Zhang pointed out from the perspective of international comparison that the growth rate of added value of China's digital economy was significantly higher than that of developed countries in Europe and the United States [9]. Chen and Zhang further analyzed the structure of digital economy and found that the structure of China's digital economy was constantly changing in recent years, and the growth rate of digital integration sector was higher than that of digital substitution sector [10]. Through literature review, it can be found that first of all, previous researches on digital economy focused more on the overall development of digital economy, without in-depth analysis of the development status of each component of digital economy. Second, there are few studies to distinguish the development of digital economy in different regions of China. Finally, the current digital economy measurement index system and methods are still not unified. Therefore, this paper will carry out research from the following aspects. Firstly, based on the understanding of generalized digital economy, the evaluation index system of regional digital economy development is established, and the China digital economy development index from 2011 to 2019 is calculated by AHP-entropy weight method. Secondly, based on the calculation results, the paper analyzes the development of China's regional economy from two dimensions of space and time, focusing on the development differences of each component of digital economy in recent years and the performance of digital economy in different regions.

Table 2: Average random consistency index.

n	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

2. Methods and Theories

2.1. Selection of Evaluation Methods. As digital economy is a complex concept involving production, consumption, infrastructure, and other fields, and its evaluation indicators are complex and diverse, accurate weighting of each indicator is helpful to measure the real situation of regional digital economy development. Therefore, this paper combines subjective and objective weights and uses analytic hierarchy process (AHP) and entropy weight method to assign weights to each index reflecting the development of regional digital economy.

2.1.1. Analytic Hierarchy Process. The analytic hierarchy process (AHP) is a systematic and hierarchical analysis method. The research object is decomposed into different factors at different levels and the relative importance of each factor is determined by pair comparison [11, 12]. The procedure for calculating index weights using AHP is as follows.

Step 1. The judgment matrix was determined by experts in related fields according to 1-9 scale method. The meaning of each score is shown in Table 1.

X is the judgment matrix:

$$X = x_{mm} = \begin{matrix} x_{11} & x_{11} & \cdots & x_{1m} \\ x_{21} & x_{21} & \cdots & x_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{11} & \cdots & x_{mm} \end{matrix}. \quad (1)$$

Step 2. Normalize X and obtain vector: w_i.

$$w_i = \sqrt[m]{x_{i1}x_{i2}x_{i3}\cdots x_{im}}. \quad (2)$$

Step 3. Calculate the weight coefficient of indicator i: ω_i.

$$\omega_i = \frac{w_i}{\sum_{i=1}^{m} w_i}. \quad (3)$$

Table 3: Digital economy development level evaluation index system.

The total indicator	The first-level indicators	The second-level indicators
Digital economy development index	Digital infrastructure (X1)	Length of optical cable (X11)
		Number of Internet broadband access ports (X12)
		Number of mobile phone base stations (X13)
	Application of digital technology (X2)	Mobile phone penetration rate (X21)
		Online mobile payment level (X22)
		Digital financial inclusion coverage (X23)
	Development of digital industry (X3)	Number of Internet domain names (X31)
		Telecommunications traffic (X32)
		Information service industry practitioners (X33)
		Output value of information service industry (X34)

Step 4. Calculate the maximum characteristic root of the judgment matrix: $\lambda_{\max}$.

$$\lambda_{\max} = \sum_{i=1}^{m} \frac{(X\omega)_i}{n\omega_i}. \tag{4}$$

Step 5. Conduct consistency test on the judgment matrix:

$$\mathrm{CI} = \frac{\lambda_{\max} - n}{n-1}, \tag{5}$$

$$\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{RI}}, \tag{6}$$

where CI is the consistency index and RI is the average random consistency index of the matrix. When CI = 0, the judgment matrix has complete consistency. The greater the CI, the lower the consistency. When CR ≤ 0.1, the consistency of the judgment matrix is acceptable. The values of RI of order 1-9 are shown in Table 2.

2.1.2. Entropy Weight Method. Entropy weight method is a kind of weighting method based on the dispersion degree of data, which has been widely used in different fields of comprehensive evaluation. The entropy weight method is completely based on the information entropy contained in the index to assign weight to the index, so its accuracy is higher, its objectivity is stronger, and it is more suitable for the weight determination of complex system [13, 14]. The basic steps are as follows.

Step 1. Construct the original evaluation matrix with m samples and n indicators.

$$X = \begin{matrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mm} \end{matrix}. \tag{7}$$

Among them, the X_{ti} is the value of the i indicator in the t sample.

Table 4: Descriptive statistics of raw data.

Variables	(1) N	(2) Mean	(3) Sd	(4) Min	(5) Max
X11	279	891198.40	736372.61	50642.62	3679239.00
X12	279	1852.17	1613.53	26.70	8538.98
X13	279	14.78	12.23	0.64	75.84
X21	279	96.97	24.64	52.04	189.56
X22	279	173.75	89.15	10.82	379.51
X23	279	583.14	3018.01	1.96	29145.12
X31	279	87.35	137.41	0.39	882.54
X32	279	1075.54	1420.07	23.90	12046.44
X33	279	21.66	26.59	0.49	167.40
X34	279	1481.86	2301.05	32.56	15947.12

Step 2. Standardize the evaluation matrix.

$$r_{ti} = \frac{x_t - \min(x_t)}{\max(x_t) - \min(x_t)}. \tag{8}$$

Step 3. Calculate the entropy value of indicator i: H_i.

$$H_i = -k \sum_{t=1}^{m} f_{ti} \cdot \ln f_{ti}. \tag{9}$$

Among them, $f_{ti} = r_{ti} / \sum_{t=1}^{m} r_{ti}$, $k = 1/\ln m$.

Step 4. Calculate the entropy weight of indicator i: ω_i.

$$\omega_i = \frac{1 - H_i}{n - \sum H_i}, (i = 1, 2, \cdots, n). \tag{10}$$

2.1.3. Comprehensive Weight and Digital Economy Development Index. As a subjective weighting method, analytic hierarchy process (AHP) can better explain the results obtained, but it also has strong arbitrariness. Entropy weight method is completely calculated based on mathematical formula, and its objectivity is beyond doubt. However, sometimes the weight obtained may be inconsistent with the actual importance, which affects

Table 5: China's digital economy measurement results.

Year	Digital infrastructure	Application of digital technology	Development of digital industry	Digital economy development index
2011	3.17	3.25	10.75	17.17
2012	4.07	5.38	12.21	21.66
2013	4.79	7.44	14.05	26.28
2014	6.19	10.40	15.04	31.64
2015	8.11	12.27	17.67	38.05
2016	9.62	14.72	18.01	42.36
2017	10.65	15.91	19.56	46.12
2018	11.47	17.31	26.08	54.85
2019	12.67	18.19	30.28	61.15
Rate of increase	299.68%	459.69%	181.67%	256.14%

the accuracy of evaluation results. Therefore, AHP and entropy weight method are combined here, and the combined weight is taken as the final result to ensure the accuracy and practicality of the evaluation results.

$$\omega_i = \alpha\omega_i^{'} + (1-\alpha)\omega_i^{''}, \tag{11}$$

where α, $\omega_i^{'}$ are the proportion and calculation result of AHP in combination and $1-\alpha$, $\omega_i^{''}$ are the proportion and calculation result of entropy weight method in combination.

Finally, after determining the weight of each evaluation index, the digital economic development index can be calculated by combining the data of each index.

$$C = \sum_{i=1}^{n} \omega_i X_i \times 100, \tag{12}$$

where C is the digital economy development index, ω_i is the index weight, and X_i is the index value. In order to give full play to the advantages of both subjective and objective methods, the proportion of AHP is set at 50% and the weight of entropy method is set at 50% when calculating the comprehensive weight.

2.2. Selection of Evaluation Indicators. Since digital economy is a complex comprehensive concept, this study follows the principles of systematicness, availability, and scientificity to construct the evaluation index system of digital economy development. This system consists of three dimensions: digital infrastructure, application of digital technology, and development of digital industry. Each dimension contains three or four secondary indicators that reflect the state of the digital economy. The specific results are shown in Table 3.

2.3. Data Description. The data used in the empirical process are from the 2012-2020 China Statistical Yearbook, China Electronic Information Industry Statistical Yearbook, and the websites of statistics at all levels. In order to eliminate the influence of statistical bias, the original data was tailed by 1% at both ends, and the effect of inflation in the data was eliminated by subtraction. The descriptive statistical analysis results of the data are shown in Table 4.

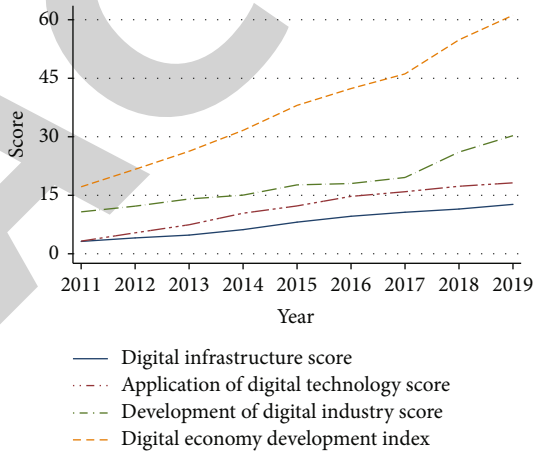

Figure 1: Variation trend of China's digital economy from 2011 to 2019.

Table 6: Annual growth rate of China's digital economy from 2012 to 2019 (%).

Year	Digital infrastructure	Application of digital technology	Development of digital industry	Digital economy development index
2012	28.54	65.78	13.54	26.19
2013	17.66	38.30	15.08	21.33
2014	29.13	39.77	7.10	20.37
2015	30.94	17.99	17.46	20.27
2016	18.74	19.94	1.95	11.33
2017	10.67	8.05	8.58	8.87
2018	7.70	8.78	33.32	18.94
2019	10.48	5.13	16.12	11.47

Table 7: Provincial regional division.

Region	Provinces
The eastern region	Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Shandong, Guangdong, Hainan
The central region	Shanxi, Jilin, Anhui, Jiangxi, Henan, Hunan, Hubei
The western region	Sichuan, Chongqing, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, Guangxi, Inner Mongolia
The northeast region	Liaoning, Jilin and Heilongjiang

3. Empirical Results and Analysis

3.1. Dynamic Analysis of the Development Level of China's Digital Economy. Table 5 and Figure 1 show the annual average of the digital infrastructure score, digital technology application score, digital industry development score, and digital economy development index of 31 provinces in China from 2011 to 2019. It is obvious that, from 2011 to 2019, China's digital economy development index increased from 17.17 to 61.15, with an increase of 256.14%. China's digital economy as a whole has achieved leapfrog development. Digital infrastructure, digital technology application, and development of digital industry have achieved remarkable growth. Digital infrastructure and digital technology application increased by 299.68% and 459.69%, respectively, exceeding the overall level of growth. Development of digital industry, grew by 181.67%, not more than the overall growth level. Compared with the digital industry in recent years, digital infrastructure and digital technology applications are more fully developed. In fact, compared with the development of digital industry, it is easier and more effective to carry out digital infrastructure and application of digital technology, such as the construction of mobile signal base station and the promotion of online payment [15–17]. Although only developing these aspects can also promote the development of digital economy, it may produce a large amount of low-level repetitive investment, which is not conducive to the sustainable development of digital economy. Digital industry is an important pillar of the development of digital economy and also the main source of economic benefits of digital economy [18]. Whether the digital industry can be fully developed will directly determine the development prospect of digital economy.

Table 6 shows the annual growth rates of various indicators of China's digital economy development. It is clear that, from 2012 to 2019, the growth rate of China's digital economy remained above 10% for a long time, except for 2017, which was 8.87%. By observing the three subindexes, it can be found that digital infrastructure and digital technology application achieved high growth from 2012 to 2016. However, since 2017, the development of both of them has declined, with the growth rate falling to about 10% and showing a trend of annual decline. On the other hand, the digital industry has been growing rapidly since 2017.

3.2. Analysis of the Development Level of Digital Economy in Different Regions. In order to analyze the specific performance of digital economy in different regions of China, this study divides 31 provinces into four regions, namely, east, central, west, and northeast, combining economic and geographical conditions. The partition results are shown in Table 7.

Table 8: Digital economy development index of different regions in China.

Year	Digital economy development index			
	East	Central	West	Northeast
2011	32.86	12.14	8.07	11.30
2012	39.62	15.87	11.30	14.84
2013	45.67	20.20	14.81	19.73
2014	52.01	26.24	19.20	24.28
2015	60.70	33.83	23.71	28.34
2016	64.25	39.53	28.16	31.90
2017	67.64	44.53	31.82	34.77
2018	74.65	59.90	39.45	40.40
2019	78.44	68.76	46.34	47.52
Rate of increase	138.71%	466.39%	474.23%	320.53%

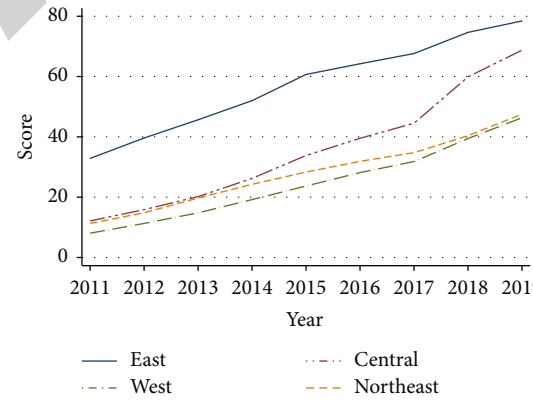

Figure 2: Variation trend of digital economy development index in different regions.

Table 8 and Figure 2 show the annual average of the digital economy development index in east, central, west, and northeast China from 2011 to 2019. It is clear that the development level of digital economy in eastern, central, western, and northeast China has been significantly improved during 2011-2019, with an increase of 138.71%, 466.39%, 474.23%, and 320.53%, respectively. The development level of digital economy in eastern and central China is higher than the national average. Although the growth of later area is extremely swift and violent, but because the base is too low, the absolute gap between regions maintains expansion state. In 2011, the digital economy

Table 9: Digital infrastructure scores of different regions in China.

Year	Digital infrastructure scores			
	East	Central	West	Northeast
2011	4.55	3.62	1.93	2.59
2012	5.97	4.55	2.49	3.16
2013	6.81	5.40	3.07	3.77
2014	8.73	7.02	3.93	5.10
2015	10.94	9.61	5.39	6.51
2016	12.04	11.92	6.88	7.99
2017	12.68	13.56	7.89	9.12
2018	13.15	14.55	8.90	10.00
2019	13.86	16.19	10.24	11.41
Rate of increase	204.62%	347.24%	430.57%	340.54%

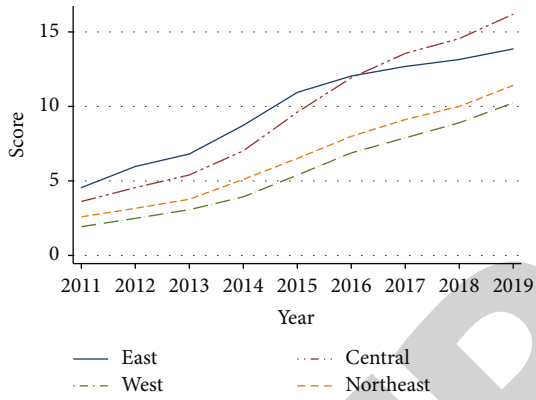

Figure 3: Variation trend of digital infrastructure scores in different regions.

Table 10: Digital technology application scores of different regions in China.

Year	Digital technology application scores			
	East	Central	West	Northeast
2011	5.74	1.97	1.99	2.55
2012	8.00	3.93	4.10	4.67
2013	10.07	5.92	6.20	6.69
2014	13.03	9.05	9.06	9.76
2015	15.16	10.98	10.70	11.55
2016	17.45	13.48	13.19	14.28
2017	18.36	15.27	14.46	14.82
2018	19.25	16.93	16.22	15.91
2019	19.70	17.99	17.39	16.81
Rate of increase	243.21%	813.20%	773.87%	559.26%

development index of eastern and western regions was 32.86 and 8.07, respectively. In 2019, the figures were 78.44 and 46.34. The east's lead over the west widened from 24.79 in 2011 to 32.1 in 2019. Therefore, the development level of digital economy in the four regions is always ranked from high to low

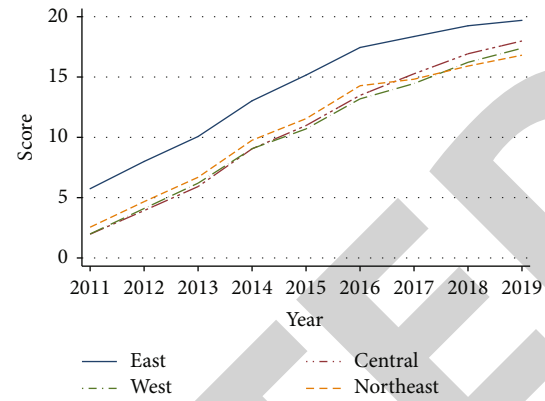

Figure 4: Variation trend of digital technology application scores in different regions.

in the order of east, central, northeast, and west. The eastern region is mostly developed coastal provinces with abundant capital and labor and obvious policy advantages. Most of China's leading Internet companies such as Alibaba, Tencent, and JD.com are located here. Therefore, the eastern region has always taken the lead in digital economy. The Internet and other industries in the digital economy are naturally monopolistic, and most of them are high-tech industries with high entry threshold [15, 19, 20], which is not conducive to the backward regions giving play to their late-mover advantages, thus increasing the difficulty of narrowing the gap in the development of the digital economy.

3.3. Analysis of Influence Factors of Regional Development Differences in Digital Economy. Balanced development is an important prerequisite for sustainable development of digital economy. However, it can be seen from the above analysis that there are great differences in digital development levels among different regions in China at present. Therefore, this paper will look for the root of the gap from three perspectives: digital infrastructure, digital technology application, and digital industry development.

Table 9 and Figure 3 show the scores of digital infrastructure in east, central, west, and northeast China from 2011 to 2019. It is obvious that, first of all, from 2011 to 2019, the scores of east, central, west, and northeast China increased from 4.55, 3.62, 1.93, and 2.59 to 13.86, 16.19, 11.41, and 10.24, indicating that the digital infrastructure of China's four major regions has been significantly upgraded and optimized in nine years. Second, the eastern region did not always maintain its leading position, being overtaken by the central region in 2017. In 2019, the difference between the highest and lowest scores was a smaller 5.95. This means there is not much difference between regions in terms of digital infrastructure construction.

Table 10 and Figure 4 show the scores of digital technology application in east, central, west, and northeast China from 2011 to 2019. It is clear that, from 2011 to 2019, the scores of digital technology application in east, central, west, and northeast China increased from 5.74, 1.97, 1.99, and 2.55 to 19.70, 17.99, 17.39, and 16.81, respectively. It shows that the application of digital technology in life and consumption in different regions of China has been rapidly

Table 11: Digital industry development scores of different regions in China.

Year	Digital industry development scores			
	East	Central	West	Northeast
2011	22.57	6.55	4.15	6.16
2012	25.65	7.39	4.71	7.01
2013	28.79	8.88	5.54	9.26
2014	30.26	10.17	6.21	9.42
2015	34.60	13.25	7.62	10.29
2016	34.76	14.13	8.09	9.63
2017	36.60	15.70	9.47	10.83
2018	42.25	28.42	14.33	14.50
2019	44.89	34.58	18.71	19.29
Rate of increase	98.90%	427.61%	350.80%	213.9%

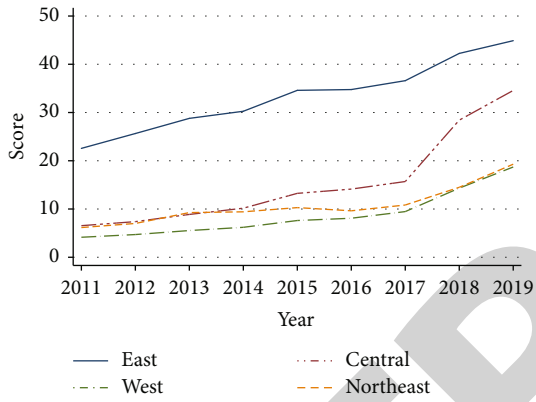

Figure 5: Variation trend of digital industry development scores in different regions.

popularized during this period, and people's acceptance of digital technology has been greatly improved. The east has always maintained a slight lead over the rest of the country, with a score difference of just 2.89 between the east and the lowest-scoring northeast in 2019, compared with 3.75 in 2011. This means that in the application of digital technology, the advantages of backwardness in backward regions have been fully brought into play, gradually catching up with the leaders, and the gap between different regions is disappearing.

Table 11 and Figure 5 show the development scores of digital industry in east, central, west, and northeast China from 2011 to 2019. It is obvious that, from 2011 to 2019, the scores of digital technology application in eastern, central, western, and northeast China increased by 98.90%, 427.61%, 350.80%, and 213.9%, respectively. Clearly, the leading eastern region is growing much slower than other regions, but that does not diminish its lead. The east scored 26.18 points higher than the west in 2019, compared with 18.42 in 2011. This means that the gap between the development levels of digital industries in different regions is widening over time. This is mainly because the initial development level of digital industry in backward regions is too weak. In 2011, the development score of digital industry in central, western, and northeast regions was 6.55, 4.15, and 6.16, while that in eastern regions was 22.57. Therefore, the huge difference in the development level of digital industry is the main factor leading to the differences in the development of digital economy in different regions of China.

4. Conclusions and Recommendations

4.1. Conclusions. By establishing the evaluation index system of digital economy development and combining AHP-entropy weight method and the comprehensive weighting method, this paper calculates China's digital economy development index from 2011 to 2019 and analyzes the development status of China's digital economy in time and space dimension according to the measurement results and draws the following main conclusions.

(1) The development of China's digital economy has always been on the rise, which is mainly driven by digital infrastructure and digital technology application. Around 2017, the development of digital infrastructure and digital technology application declined, but the digital industry has entered a period of rapid development since 2017

(2) Digital economy in different regions of China has maintained rapid development, but there is a large gap in the development of digital economy in different regions, and this gap is continuously expanding. Therefore, the development level of digital economy in the four regions is always ranked from high to low in the order of east, central, northeast, and west

(3) The development level of digital economy in eastern China is far ahead of other regions, which is not all-dimensional but only in the development of digital industry. After a long period of development, the central, western, and northeast regions have gradually caught up with the east in terms of digital infrastructure and digital technology application

4.2. Recommendations. First of all, digital infrastructure is the cornerstone of the development of the digital economy, so we should further promote the construction of digital infrastructure but pay attention to screening and avoid meaningless and repetitive investment. Secondly, we should give full play to the role of digital industry in promoting the development of digital economy, crack down on the monopolistic behavior of digital industry, improve the profitability of digital industry, and promote the endogenous development of digital economy. Finally, the comparative advantages of different regions should be explored, and regional linkage should be realized by using policies such as "channel more computing resources from the eastern areas to the less developed western regions" to make up for shortcomings and achieve balanced development of digital economy.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

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Research Article

Target Detection and Network Optimization: Deep Learning in Face Expression Feature Recognition

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Facial expression recognition technology has been more and more in demand in security, entertainment, education, medical, and other domains as artificial intelligence has advanced, and face expression recognition technology based on deep learning has become one of the research hotspots. However, there are still some issues with the existing deep learning convolutional neural network; the feature extraction technique has to be improved, and the design of the detailed network structure needs to be optimized. It is critical to do more research on the deep learning convolutional neural network model in order to increase the accuracy of face facial expression detection. In this paper, a deep learning convolutional neural network structure combining VGG16 convolutional neural network and long and short-term memory networks is designed to address the shortcomings of existing deep learning methods in face expression recognition, which are prone to overfitting and gradient disappearance, resulting in low test accuracy. This structure easily and effectively collects facial expression information and then classifies the retrieved features using a support vector machine to detect face expressions. Finally, the fer2013 dataset is used to train face expression recognition, and the results demonstrate that the built deep convolutional neural network model can effectively increase face expression identification accuracy.

1. Introduction

There are many ways for people to communicate with each other: language, text, action, etc., and expression is also one of the important ways. With the rapid development of artificial intelligence, how to achieve the detection and accurate recognition of human face expressions has become a hot research topic in artificial intelligence nowadays [1]. Facial expression recognition technology has broad application scenarios in psychological guidance, entertainment, security, online education, and intelligent medical care [2]. Facial expression recognition can be applied to fatigue driving monitoring, using the camera to capture the real-time expression of the driver, analyze the driver's mental state, and send out alerts when the driver's face is tired, which can prevent traffic accidents caused by fatigue driving to a certain extent; in nursing homes or empty nest elderly homes, the installation of human-computer interaction system with facial expression recognition function can help the elderly with limited mobility and mental state. In the process of online teaching, it is difficult for the teacher to observe each student's reaction as in offline teaching, so as to adjust the progress of the course in time, but the facial expression recognition system can monitor the students' reaction to the lecture and give feedback to the teacher in time, which can help improve the teaching quality to a certain extent [3].

The traditional face expression recognition method is to capture the image and extract the image features first and then use the machine learning method to recognize the image, but this method has certain limitations, the feature extraction process is complicated, and the recognition performance is easily disturbed by the external environment and the face action [4]. In recent years, with the development of deep learning, convolutional neural networks are gradually applied to the image processing field and have

high accuracy, but there are still some shortcomings; for example, the network size needs to be further compressed so as to save space, and the operation efficiency and recognition accuracy still need to be improved; the image features may be overfitted when extracted; the shift of input data dimensionality leads to easy gradient disappearance and gradient. The existing algorithm is still difficult to handle dynamic images; the adaptability of the algorithm application is poor; more practical applications about face expression recognition are yet to be developed, etc. [5].

To address the aforementioned issues, this paper proposes a structure that combines VGG16 convolutional neural network with long and short-term memory networks. First, VGG16 convolutional neural network is used to extract face features efficiently and accurately, and then, long and short-term memory networks are combined to predict and analyze image sequences for efficient and accurate expression recognition. To maximize the network parameters, a multilayer network TAFMN activation function is presented. The TAFMN activation function can convert difficult nonlinear conditions into linear conditions and extract deep features of pictures more easily and rapidly, allowing deep learning convolutional neural networks to recognize facial expressions with greater accuracy [6]. The model can effectively detect facial expressions on the fer2013 dataset after experimental tests, and this optimized network model has good feasibility and accuracy [7].

2. Review of the Literature

People have been researching and applying face expression recognition since the dawn of artificial intelligence. The present state of facial recognition technology may be classified into two categories: classical approaches and deep learning methods.

2.1. Application of Traditional Methods in Face Expression Recognition. In 2005, Peterson Joshua et al. proposed the method of using infrared illumination to achieve the capture and recognition of human face expressions [8]. Even if the head moves in different situations, this approach employs an active near-infrared light source imaging with a higher intensity than ambient light, and with the matching wavelength optical filter, a steady facial picture may be created. On this image, dynamic Bayesian network (DBN) modeling is used to extract the image features and further eliminate the monotonic changes of the image, forming a dynamic and highly reliable face expression recognition system [9].

With the development of 3D technology, in 2006, Oruganti and Namratha proposed to apply 3D technology to facial expression recognition. First, the facial expression images were captured by a camera, and a preliminary 3D model was obtained by stereo reconstruction of these images. Different expression images will construct different 3D models, extract the deformation parameters of the 3D models, and recognize and classify different expression images by analyzing the deformation parameters [10].

In 2009, Hongxue and Kongtao used local binary pattern (LBP) to do face expression recognition. First, the theoretical positions of the five facial features are calculated using the projection method. Then, the actual positions of the five senses captured by the camera are compared with the previously calculated theoretical positions to perform face expression recognition [11].

AG et al. used support vector machine (SVM) in the face expression identification process in 2015. With the use of the SVM classifier, AG et al. categorised facial emotions into angry, pleased, astonished, sad, disgusted, natural, and scared [12]. Then, the input images were compared with each category.

In 2017, Weilong et al. used a combination of methods for expression recognition, which include local binary patterns, facial markers, histogram of oriented gradient (HOG), and SVM. Firstly, facial flags are set on the input expression image and local binary model is built, then local binary features are extracted using histogram of oriented gradient, and finally, SVM is used to classify the features to complete the final expression recognition [13].

2.2. Application of Deep Learning on Face Expression Recognition. In recent years, the mainstream way of face expression recognition is to use convolutional neural network (CNN) for deep learning. The multiple convolution and acquisition layers in convolutional neural networks can extract higher-level features of face expression images and accurately classify these deep image features, which have achieved good results in FER. After training, convolutional neural networks are currently the best among many kinds of neural networks for image recognition [14].

In 2014, Ijjina and Mohan first proposed the use of deep convolutional neural networks for face expression recognition. The previous convolutional neural networks do not analyze face expressions deeply enough and are easily disturbed by external conditions. In contrast, deep convolutional neural networks can use multilayer structure and activation function for local discrimination to analyze deep features of face expression images and reduce the interference of external environment and face action. It was trained on EURECOM kinect facial dataset and achieved good results in face expression recognition.

In 2015, Lei et al. proposed that multichannel convolutional neural networks can be used for face expression recognition [15]. They designed a two-channel convolutional neural network with two channels using different feature extractors: an unsupervised trained convolutional autocoding feature extractor and a standard convolutional neural network feature extractor. After extracting the features, a fully connected layer is used to synthesize the image features for analysis and classification. Using JAFFE dataset for training, this two-channel convolutional neural network has higher recognition rate [16].

In 2016, Shijia et al. focused on the application of convolutional neural networks for the recognition of real-world faces. The dataset used for the training of the convolutional neural network is mostly from the face expression images on the Internet, which is too small and lacks universality. Since the face expressions to be recognized in real-world scenarios are more complex and variable and have more

environmental interference, the convolutional neural network trained with these expression images cannot solve the real-world face expression recognition problem well. So Shijia et al. created their own new face expression dataset and used several different camera models for different lighting conditions during the filming process in order to make the data more general and trained the convolutional neural network with the new dataset created [17].

K. Sha et al. employed deep convolutional neural networks to create a face expression detection system with four components: an input module, a preprocessing module, a recognition module, and an output module in 2017. The system is able to extract deeper image features due to the preprocessing of the input facial expression images, the learning rate of the convolutional neural network is significantly increased, and the K-nearest neighbor algorithm is added to the recognition module for data fitting. In order to have higher generality and make the results more convincing, the system is trained simultaneously with the public dataset Cohn-Kanade and the expression dataset JAFFE, which focuses on Japanese female facial expressions. The experimental results show that the facial expression recognition system can accurately recognize human facial expressions.

In 2018, Zheng et al. improved the algorithm of deep learning and proposed a simpler and faster centralized coordinate learning (CCL) method [18]. This method forces the feature vectors to be decentralized and arranged on a sphere spanning the whole coordinate space in order to enhance the discriminative ability, merges the multiplicative angle residual and additive cosine residual into the soft-max loss function, respectively, and further proposes the adaptive angle residual to enhance the discriminative ability of facial features. To improve the training efficiency, the centralized coordinate learning model is trained with a small CASIAWebface dataset, which has about 10,000 460K facial images, and the training results show that the centralized coordinate learning model can accurately recognize facial expressions of human faces [19].

In 2019, Ananth and Rajendrane proposed a new network architecture for end-to-end facial expression recognition combined with an attention model, which constructs an attention model on the human face and uses a Gaussian function to process the input data and analyze the stereoscopic structure to recognize facial expressions. The core of this network architecture has two parts: the first part is responsible for face expression image capture and correction, first extracting features with encoder, decoder network, and convolutional feature extractor, then arranging pixels into matrices, and performing multiplication of matrices to obtain feature attention maps; the second part is responsible for obtaining the representation and classification of embedded facial expressions. To demonstrate that the designed network architecture has higher recognition rate, Ananth and Rajendrane combine the traditional BU3DFE and CK facial dataset to form a larger and more comprehensive synthetic dataset, use this synthetic dataset for training, and compare the results with other previous network architectures to verify that the network architecture of end-to-end facial expression recognition combined with attention model has recognition with high accuracy [20].

3. Emotion Recognition Network Construction

Since the captured facial expression information usually exists in image format, it is often trained using image sequences in deep learning to recognize facial expressions more accurately. Convolutional neural networks have good performance in picture recognition and can extract the depth features of images, while long short-term memory networks are obtained by improving on the recurrent neural network model and have good ability to handle sequence data. As a result, the two may be utilized together for facial expression sequence identification, with the convolutional neural network's feature recognition and the long and short-term memory network's data processing. To begin, convolutional neural networks are utilized to extract deep visual characteristics from sequential facial expression image sequences, removing the impact of face motions and lighting conditions to increase face expression recognition accuracy. The optimal network is then built by combining the long and short-term memory network with a convolutional neural network that extracts deep visual features, and the long and short-term memory network synthesizes the sequence information into the network model using deep learning.

3.1. Convolutional Neural Network Selection. Convolutional neural network is a feed-forward artificial neural network divided into three processes: input, processing, and feedback. It is inspired by the neural tissue cell structure of animals, where individual nerve cells in the brain have only the edge part to respond to external stimuli. Based on this special structure, convolutional neural network performs well in many deep learning tasks such as speech-to-text conversion, image recognition, and language translation. At the receiver side of the convolutional neural network, various types of data such as audio, video, and image can be input, which form one or more vector arrays. The vector arrays have their own unique features, and these features are extracted and compared with the predefined features for classification, and the similarity reaches a certain degree to be classified into one category. In the process of supervised learning, the convolutional neural network is trained with training data of known mapping relationships, and the convolutional neural network can automatically adjust the parameters to form the mapping relationships that meet the actual needs after learning. In this process, a large amount of training data is usually required, and both the amount of data and the depth of the network have a great impact on the model accuracy.

Convolutional neural networks have several layers: a convolutional layer, a pooling layer, a rectified linear unit layer, a fully connected layer, and a loss layer. The convolutional layer is the core component of the convolutional neural network algorithm. The number of layers in the convolutional layer may be adjusted according to the technique and the real requirements, and each layer can extract features from the input picture using different methods. Under nonlinear situations, the pooling layer samples the input data. Maximum pooling layer and average pooling layer are the two most popular forms of pooling layers.

The maximum pooling layer can be used in the final display of the image. Rectified linear layers are usually applied after each convolutional layer. When dealing with nonlinear features such as hyperbolic tangent and S-shaped functions, rectified linear layers use a variety of basic operations to solve the problem of gradient disappearance and gradient explosion, transforming nonlinear problems into linear ones and improving the accuracy rate. The last part of the convolutional neural network is the fully connected layer, which is responsible for processing the final output of the whole neural network. The output is usually an N-dimensional vector, and N is the number that must be chosen for program classification. Suppose a numerical classifier is needed, and if there are 8 numbers, N equals 8. Assuming that the numerical classification process results in an N-dimensional vector of [0.18 0.02 0.64 0 0.06 0 0 0 0], the test image has a probability of 1 for 18%, 2 for 2%, 3 for 64%, 5 for 6%, and 0 for all other probabilities.

The convolutional neural network model used in this paper is the VGG16 convolutional neural network model. The convolutional layers use 3×3 kernels, and the step size and padding are set to 1 to ensure that two adjacent convolutional layers have the same spatial dimension. Rectified linear unit activation is performed immediately after each convolution, and the maximum intersection operation is used at the end of each block to reduce the overall size of the network. The maximum pooling layer uses a filter of size 2×2. To ensure that the two adjacent pooling layers have the same spatial dimension, the padding and step size are set to the same, and to ensure that each spatial dimension of the activation mapping from the previous layer is halved, the padding and step size are both set to 2. Then, it goes through 3 fully connected layers, the first two fully connected layers consist of Relu activation function and the last fully connected layer consists of soft-max loss function.

The VGG16 convolutional neural network has two main drawbacks: first, the training speed is very slow because of the complex and large structure with many layers; second, the network architecture has too many parameters, with more than 100 million parameters in total, 90% of which are located in the fully connected layers, which will occupy a large amount of memory space and seriously affect the operation speed.

Based on these two shortcomings, this paper improves the VGG16 convolutional neural network in two aspects, namely, improving the training speed and reducing the number of parameters.

3.2. Long Short-Term Memory Network Selection. Long short-term memory network (LSTM) is a special form of recurrent neural network (RNN). Recurrent neural network was born in the 1980s, but it was not until the beginning of this century that it was really used as an algorithm for more effective convolutional neural networks. Recurrent neural networks have different structures, one of which is the long and short-term memory network. The input data of a recurrent neural network is usually in the form of a sequence. After the input sequence, the recurrent neural network processes the sequence recursively in order and outputs it after reaching a certain number of cycles. The structure of a recurrent neural network is shown in Figure 1.

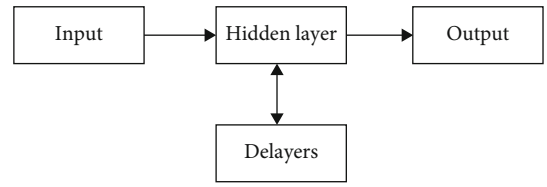

Figure 1: Structure of recurrent neural network.

From Figure 1, we can see that in recurrent neural network, the hidden layer, delayers, and outputs share the weights among them, so the recurrent neural network has some memory function. Based on the memorability of recurrent neural network, this network has important applications in video and audio processing recognition, contextual text detection and prediction, and contextual semantic recognition.

The long and short-term memory network introduces unit gates and functions with special functions based on the recurrent neural network, which can not only remember something but also selectively forget and input.

3.3. Optimized Neural Network Structure Construction. In this study, we combine a convolutional neural network with a long and short-term memory network to capture the characteristics of face expression sequences. The long and short-term memory network learns the laws of face expression sequences in detail to perform face expression identification. The neural network contains the following three parts: CNN feature sample layer, LSTM feature learning layer, and SVM feature classification layer. First, the input original image sequence $X = \{X1, X2, \cdots \cdots, x\}$, the image of one expression in the database is extracted into N frames, and the features of the expression image corresponding to N CNNs are extracted to form the CNN feature sample layer. The CNN feature sample layer extracts the features of the input face image, which takes two-dimensional image data for feature extraction, forms a one-dimensional array, and retains most of the information by performing convolution on the original data, generating image abstract features by cross-convolution and merging, pooling, and other layer-by-layer operations. The CNN feature sample layer uses the VGG16 convolutional neural network, but since the parameters of VGG16 are concentrated in the last three fully connected layers, in order to reduce the size of the network, the last three fully connected layers are removed and only the previous convolutional and pooling layers are taken and input to the average sampling layer, which averages the $X - +1$, $_{X-+2}$, and X of the K consecutive features of the images. Each layer of the CNN is connected to a single LSTM, and the upper N and lower N LSTM layers are connected to each other to form an LSTM feature learning layer. The function of the LSTM feature learning layer is to perform feature learning of the feature vectors generated from the images, which includes image data preprocessing, face detection, convolutional feature learning, and feature sampling. Finally, an optimized support vector machine- (SVM-) based feature

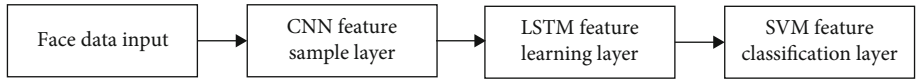

Figure 2: Overall structure of DCNNBEA network.

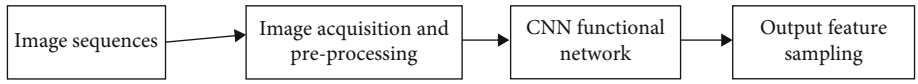

Figure 3: Basic schematic diagram of feature extraction layer.

classification layer is formed to perform feature selection using the SVM classifier. The overall structure of the designed DCNNBEA network is shown in Figure 2.

However, there are some problems with this model: first, the initial trial values of the model parameters need to be set reasonably, and the selection of the initial values is very important, and inappropriate values may lead to overfitting of the data; second, although the model has good feature extraction capability, the number of calculations is too many, which leads to too slow operation speed.

To address these two problems, the CNN feature sample layer is improved by using an average sampling layer to remove random interference and increase stability, and its basic principle diagram is shown in Figure 3.

4. Experimental Results and Analysis

4.1. Optimization of Expression Recognition Algorithm Network Parameters. Although the DCNNBEA network model can significantly improve the accuracy of convolutional neural network, it may be overfitted in the process of picture feature extraction, the problem of gradient disappearance in the process of converting two-dimensional data to one-dimensional data, the difficulty of taking reasonable initial values of network parameters, and the poor adaptability of algorithm application. These problems affect the accuracy of the facial expression feature recognition model to a certain extent. Therefore, this paper investigates the problems related to the gradient disappearance during the conversion of two-dimensional data into one-dimensional data and the low recognition accuracy due to the difficulty of taking reasonable initial values of the network parameters and proposes a multilayer network TAFMN activation function based on the Relu function.

4.1.1. Single-Layer Activation Function Research Selection. Since the activation function can substantially improve the working accuracy and efficiency of neural networks, it is widely used in neural network models.

The sigmoid function and tanh function are the two most common activation functions, where the tanh function is a kind of deformation of the sigmoid function.

The formula of the sigmoid function is shown in

$$s(y) = \frac{1}{1 + e^{-y}}. \tag{1}$$

The tanh function can be expressed as

$$\tanh y = \frac{2}{1 + e^{-2y}} - 1. \tag{2}$$

Rectified linear unit (Relu) is an integral part of the neural convolutional network, and its main role is to carry out the transformation between nonlinear features and linear features. Since the calculation of nonlinearity is too complicated and difficult, it is necessary to transform the input data into linear features, and the rectified linear unit can effectively improve the accuracy and efficiency of convolutional neural network model training.

Rectified linear unit is a kind of nonlinear activation function, and according to the characteristics of the Relu function itself, its computational expression is as in

$$\mathrm{Relu}(y) = \begin{cases} 0 & \text{if } y < 0, \\ y & \text{if } y \geq 0. \end{cases} \tag{3}$$

From equation (3), it can be seen that the Relu function is much simpler to calculate and only needs to be taken according to two ranges of the input value y. It does not need exponential and fractional calculation like the sigmoid function or tanh function, so most activation functions of convolutional neural networks are designed based on the Relu function and improved according to the desired function. The TAFMN activation function proposed in this paper is an improvement of the Relu activation function. To simplify the calculation, the linear calculation method is still used as the main calculation method, but because the gradient of the convolutional neural network model is unstable and will have problems such as gradient disappearance and gradient explosion as the number of layers increases, the initial value selection may also lead to problems such as overfitting or poor fitting performance, so it needs to be combined with other computational methods so that it can be applied to more complex convolutional neural network models.

4.1.2. Activation Function Design for Multilayer Networks. Although the Relu activation function is simple and fast to compute, commonly used, and can effectively increase the accuracy and efficiency of convolutional neural network model training, it still cannot meet the need for higher accuracy and efficiency of convolutional neural network models. In order to improve the computational rate, the parameters

of convolutional neural network should not be too many; attention should be paid to prevent the problems of gradient disappearance and gradient explosion as well as overfitting. To address these problems, a trainable multilayer maximum network TAFMN activation function is proposed in this paper.

The TAFMN activation function can be used to represent various linear and nonlinear relationships, and can simultaneously have functions that different single-layer activation functions have, such as the Relu activation function commonly used in convolutional neural networks. Because the maximum output function can provide similar functions as the Relu activation function, the TAFMN activation function proposed in this paper is a multilayer network activation function that aggregates multiple maximum output activation functions and thus has the activation function functions of each single layer. Even for the hidden and difficult to extract potential features that need to be extracted, it can be achieved by applying the multilayer activation function to the convolutional neural network. There are many complex problems to be solved in the process of face expression recognition, because faces are differentiated, the position and shape of the five senses are different for different expressions, and some subtle expressions are not easy to be detected, so deep features need to be extracted to improve the accuracy of face expression recognition.

The TAFMN activation function has two main features: first, although the TAFMN activation function is a nonlinear function, it is a linear function on the local segments, so the TAFMN activation function can solve the problem of gradient disappearance and gradient explosion during the training of neural network like the Relu function, which effectively improves the effectiveness and accuracy of the training work of neural network structure; second, the TAFMN can perform deep learning, and since it is a deformation of the maximum output function, the parameters of the activation function which can be changed according to the different neural network models to achieve the purpose of assisting the neural network to extract the effective features. Based on these two features of the TAFMN activation function, it is clear that the TAFMN activation function is capable of solving more complex problems and can be applied to complex network models. However, care should be taken not to have too many parameters; otherwise, it will lead to longer training processing time.

The technique of face facial expression recognition is used in the application, and the process is shown in Figure 4.

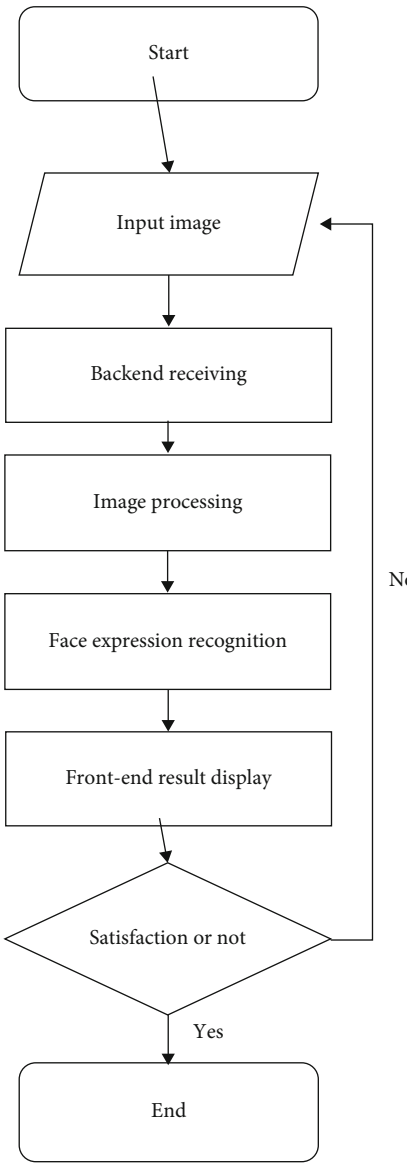

Figure 4: Flow chart of recognition.

4.2. Experimental Dataset. During the experiments, the designed deep learning convolutional neural network is trained using the expression images in the fer2013 dataset. The fer2013 dataset is derived from the 30th Machine Learning Conference held in Atlanta, Georgia, USA. The fer2013 database has nearly 30,000 face expression training images with 48×48 pixels, and there are seven expressions in this database: neutral, happy, sad, surprised, angry, disgusted, and fearful. The distribution of fer2013 expressions is shown in Figure 5.

4.3. Experimental Training Design and Result Analysis of VGG16 Model. In this paper, we first combine the improved VGG16 pretraining model and the long and short-term networks to form the DCNNBEA network and then train the network model with fer2013 dataset. The framework of TensorFlow is used to write the training network in python, and a computer with Windows 10 is used for training and accelerated with a GTX1060 GPU. The learning rate is initialized to 1, and batch normalization is added after each convolutional layer and pooling layer. The batch size was set to 256. The time used for training was 78 hours. The best classification accuracy was obtained after 270 time periods for the selected models. 128000 randomly selected data in fer2013 dataset were used as training data.

Figure 6 shows the training accuracy and testing accuracy of the VGG16 pretrained model.

From Figure 6, we can see that as the number of training steps increases, the accuracy rate will be higher. When the number of training steps is 50,000, the training accuracy is 0.65 and the test accuracy is 0.42; when the number of training

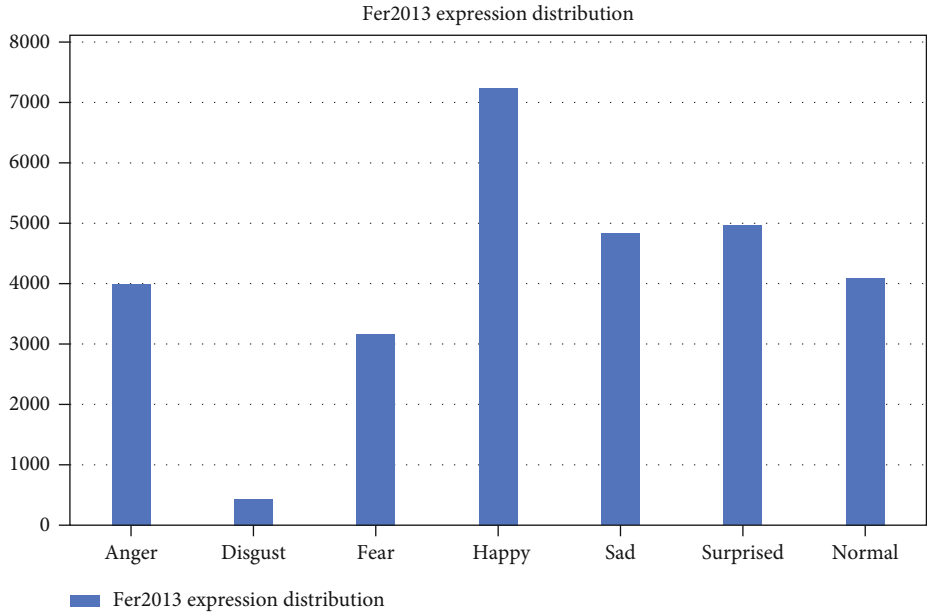

Figure 5: Distribution of fer2013 data expressions.

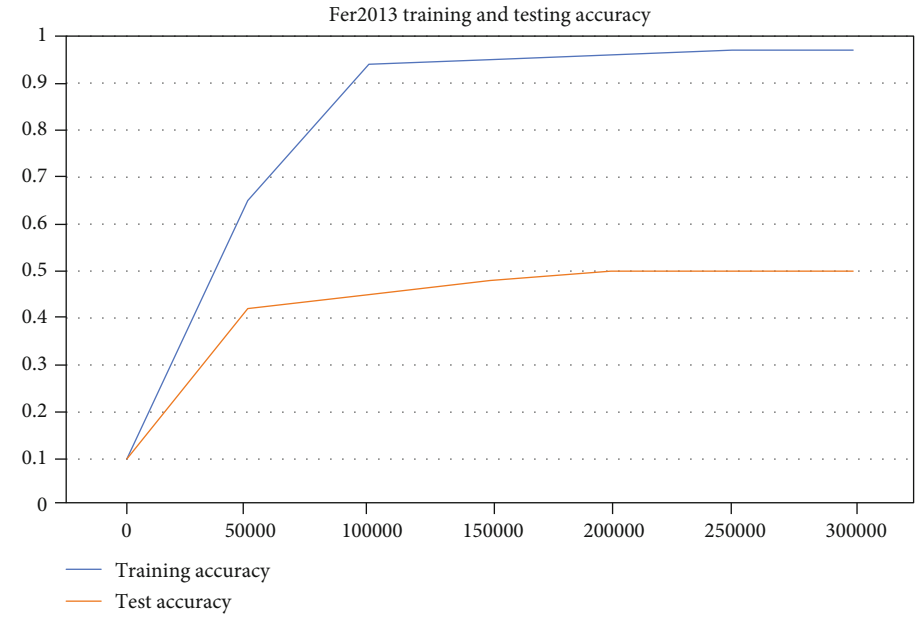

Figure 6: Visualization of fer2013 training and testing results.

steps is 70,000, the training accuracy is 0.74 and the test accuracy is 0.46; finally, when the number of training steps is 100,000, the training accuracy is 0.967 and the test accuracy is 0.498. After convergence using batch normalization of about 100000 steps, the accuracy basically no longer varies with the number of training steps. Meanwhile, the learning rate has a great influence on the convergence speed of the curve, and the curve converges fastest when the learning rate is 1.

When the number of training steps is less than 100,000, both the training accuracy and test accuracy grow rapidly, but when the number of training steps is greater than 100,000, the training test rate and test accuracy gradually level off, and finally, the training test rate grows to 96.7% and the test accuracy grows to 49.8%. It indicates that the designed DCNNBEA network structure has a high accuracy rate and can effectively recognize human face expressions.

From Figure 7, to prove that the neural network structure designed in this paper has better results compared with other networks, the experiment was repeated on AlexNet, VGG16, VGG19, and Resnet152 network structures. The experimental results are shown in Figure 7. The final test accuracies obtained from this experiment on these networks were 15.2%, 37.4%, 39.7%, and 48.7%, respectively. On these

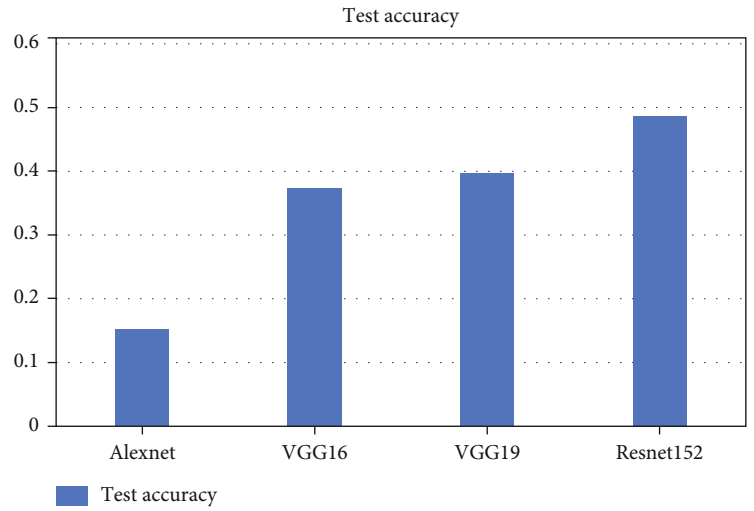

Figure 7: Test accuracy.

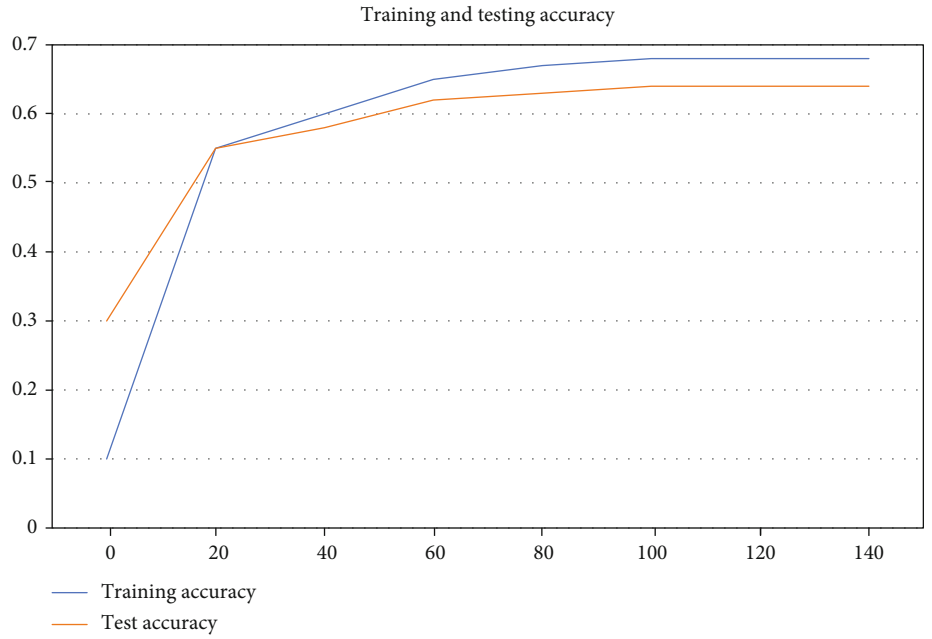

Figure 8: Training test visualization.

networks, Resnet152 had the highest test accuracy: 48.7%, but the identification method proposed in this paper obtained an even higher test accuracy: 49.8%.

4.4. Experimental Results and Analysis after Activation Function Improvement. The TAFMN activation function was added to the DCNNBEA network for training. The TensorFlow framework was used to write the training network in python, and the training was performed on a Windows 10 computer with a GTX1060 GPU for acceleration to improve the running efficiency. The total training time was 68 hours. To ensure maximum convergence speed, the learning rate was set to 1, and batch normalization was added after each convolutional layer and pooling layer, with batch size set to 256.

The running results of the training and testing process are shown in Figure 8.

As can be seen in Figure 8, the training accuracy and test accuracy are much closer than before using the activation function, and both values have increased. When the number of iterations was 40, the training accuracy was 0.6 and the test accuracy was 0.58; when the number of iterations was 80, the training accuracy was 0.67 and the test accuracy was 0.63; when the number of iterations was 120, the training accuracy was 0.68 and the test accuracy was 0.64. When the number of iterations exceeded 130, the test accuracy leveled off and finally stabilized at 68.4%. This indicates that the overall recognition accuracy of the convolutional neural network has been improved after adding the activation function, and the overfitting prevention performance of the network training has also been improved.

5. Conclusion

5.1. Summary of Full Paper Work. This paper focuses on deep learning-based facial expression feature recognition technology. In view of the problems of the current deep learning-based face expression recognition technology, the text makes reasonable improvements to the existing network structure and activation function to improve the accuracy of face expression recognition, and the experimental results verify the effectiveness of the network structure and activation function designed and proposed in the paper.

The main research of this paper has two main points.

First, a network framework for deep learning algorithm for face expression recognition is designed. When processing dynamic face expression sequences, the size of the convolutional neural network framework is too large due to too much data and parameters, which seriously affects the training speed and operation efficiency of the system. To address these problems, this paper designs a deep learning convolutional network structure that can recognize facial expression features, namely the DCNNBEA network structure. This structure is based on the VGG16 network structure by replacing the fully connected layer with the average sampling layer, which has more concentrated parameters, and combining it with the long and short-term memory network, which can achieve both simplifying the structure of the convolutional layer of the network, reducing the parameters, and improving the processing ability of the input face expression images. Finally, the network is trained with fer2013 standard face expression dataset, and the accuracy of face expression recognition test is 49.8%.

Second, the TAFMN activation function is proposed and the parameters of the face expression recognition algorithm are optimized. The selection of parameters affects the training effect of the whole convolutional neural network. Too many parameters that are too complex will produce gradient explosion, while too few parameters or too much similarity will lead to overfitting, all of which will reduce the accuracy of face expression recognition. In this paper, we design a multilayer network TAFMN activation function, which can modify its own parameters by learning to perform linear computation, nonlinear computation, and the transformation of both. By applying the TAFMN activation function to the convolutional neural network, the parameters can be continuously optimized to reduce the possibility of gradient elimination or gradient explosion. The neural network is trained with fer2013 standard face expression dataset, and the convolutional neural network face expression recognition algorithm with optimized parameters obtains a test accuracy of 68.4%, which is much higher than that of the neural network without TAFMN activation function.

The deep learning convolutional neural network model constructed in this paper has two innovative points: first, the designed DCNNBEA network can recognize dynamic expression sequences. The DCNNBEA network uses fewer parameters than other networks, and the size of the network is smaller, which can handle dynamic expression sequences more efficiently. DCNNBEA combines VGG16 network and long and short-term memory network to extract features of face expression images accurately and quickly with high feature extraction rate and recognition accuracy; secondly, the parameters of face expression recognition algorithm are optimized using multilayer network TAFMN activation function. The TAFMN activation function can optimize the parameters through training, select suitable initial values, realize nonlinear to linear transformation, solve the problem of gradient disappearance and gradient explosion in deep convolutional networks, and improve the face expression recognition accuracy.

5.2. Outlook of Next Work. Although some work has been done in this paper on the research of facial expression feature recognition based on deep learning, these works cannot meet the current demand of human-computer interaction system for facial expression recognition yet, and the convolutional neural network model still has some defects and problems, so two future research directions are proposed here.

First, there is still room for improvement in data processing. When capturing face expression images, the lighting of the external environment and the degree of face tilt can interfere with the input data; in addition, the original size and pixel characteristics of the photo can also affect the accuracy of face expression recognition. Therefore, it is necessary to further improve the algorithm to extract deeper features, reduce the sensitivity of the convolutional neural network model to these influencing factors, and improve the accuracy of face expression recognition.

Second, although improvements have been made in network optimization, there is still room for further improvement. The current training method has a large randomness, so we should study the principle of convolutional neural network in depth and explore a better training method, so that the neural network can analyze the reasons for matching the results with the dataset by itself and improve the efficiency of deep learning.

Data Availability

The labeled datasets used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

Acknowledgments

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Retraction

Retracted: Personalized Book Recommendation Algorithm for University Library Based on Deep Learning Models

Journal of Sensors

Received 19 December 2023; Accepted 19 December 2023; Published 20 December 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] D. Hou, "Personalized Book Recommendation Algorithm for University Library Based on Deep Learning Models," *Journal of Sensors*, vol. 2022, Article ID 3087623, 6 pages, 2022.

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Research Article

Personalized Book Recommendation Algorithm for University Library Based on Deep Learning Models

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Personalized recommendation is one of the important contents of personalized service in university libraries. Accurate and in-depth understanding of users is the premise of personalized recommendation. This paper proposes a personalized book recommendation algorithm based on deep learning models according to the characteristics and laws of user savings in university libraries. The method first uses the long short-term memory network (LSTM) to improve the deep autoencoder (DAE) so that the model can extract the temporal features of the data. Then, the Softmax function is used to obtain the book recommendation result of the current user. The proposed method is verified based on actual library lending data. The experimental results show that the proposed method has performance advantages compared with several existing recommendation methods.

1. Introduction

The application of "Internet +," social network, and other technologies in the library provides multisource data for user analysis, intelligent, and personalized digital library resource recommendation services, which will greatly improve users' learning efficiency and experience. It is a meaningful work to help the scholars focus on how to mine users' preferences and interests so as to satisfy them through recommendation services. Therefore, personalized digital library resource recommendation technology has gradually become a hot research point in the field of education and intelligence [1–4].

Early recommendation systems mainly used collaborative filtering (CF) algorithms. The main types of CF algorithms can be divided into user-based and item-based ones. Both types of algorithms need to be based on the constructed binary co-occurrence matrix of users and items and cooperate with the entire matrix data to predict the user's response to the item. User-based CF needs to calculate the similarity between users and find users similar to the target user. Then, the weighting process is performed to sum up the scores of similar users as the target user's predicted score for the item. The scores are sorted to generate a list of recommended items. Reference [5] proposed a recommendation method based on CF, which mainly recommended products based on preferences with other users who like the item. Based on the recommendation accuracy evaluation indicators, CF recommendation has been greatly improved and gradually accepted by academia and business circles. However, this recommendation method only utilizes shallow model dependencies, which cannot learn deep feature representations for users and items, and lacks interpretability compared with many content-based algorithms. Based on the above problems, many researchers have improved the CF recommendation algorithm from different aspects. Literature [6] further combined the latent factor model (LFM) with CF, which made the CF algorithm a step forward. Literature [7] proposed a CF method based on matrix factorization (MF) and its variant algorithm, and experimental results showed that this method was more effective in rating prediction. However, the "latent factors" in latent models were not intuitively explanatory, making it difficult to understand why an item predicts a higher rating and is recommended. Although the traditional content-based recommendation methods can improve the interpretability of the recommendation, it extracts user-item features

based on a shallow model for recommendation. This feature extraction method relies heavily on artificially designed features, which seriously restricts the effectiveness and scalability of recommendation.

With the development of computer technology, artificial intelligence technology, and other fields, deep learning technology has been widely used in speech recognition, image processing, etc. This technology can not only accurately obtain the relationship between users and items in diverse data, but also can convert abstract codes into high-level data information. Therefore, deep learning technology is widely used in recommender systems. In [8], the deep learning model was fused with CF and applied in movie recommendation. Inspired by the good performance, more and more researchers have carried out research on deep learning network models applied to recommender systems. Literature [9] proposed a recommendation model based on long short-term memory network (LSTM) for course association classification. First, the generalized sequential pattern mining algorithm and spectral clustering algorithm were used to group courses, and then LSTM was used to model the time series of courses. Finally, the courses are classified using the Softmax function. The experimental results showed that the proposed algorithm has higher recommendation accuracy than other algorithms such as CF. Reference [10] proposed a recommendation model based on gated recurrent unit (GRU) and the relationship between courses. Combined with the relationship between courses, GRU and Softmax function were used to recommend courses. The experimental results showed that compared with the recommendation algorithm using CF, the recommendation accuracy rate was much higher. Reference [11] employed an autoencoder to map data into a nonlinear latent space, and experimental results showed that it had a lower mean square error than CF. Reference [12] combined the evaluation information and auxiliary information such as user attributes and item descriptions and used autoencoders to decompose the matrix. It also verified the effectiveness of the method through experiments.

Due to the powerful nonlinear mapping ability of deep learning when processing high-dimensional data, it can be effectively mapped to low-dimensional space to extract high-level features. The recommendation has also been widely used [13–16]. Due to the powerful latent feature learning ability of deep autoencoder (DAE), it can effectively deal with the problem of data sparsity [17]. In addition, because users often consider the previous book when borrowing new books, the user's borrowing sequence has obvious time series characteristics. LSTM has a strong time series modeling ability, which can effectively process time series data. According to the above characteristics, this paper uses LSTM to improve the DAE and applies it to personalized book recommendation in university libraries. The proposed method recommends future borrowed books according to the user's borrowing history [18–20]. The experiment is carried out based on the real loan data of the library, and the proposed method is compared with several existing prediction models. The experimental results show that the recommended results of the proposed method are closer to the actual results, reflecting its higher effectiveness.

2. Method Description

2.1. LSTM. The borrowed data of readers has a certain time sequence. According to the characteristics of the neural network, this paper chooses the LSTM as the basic model to perform deep learning on the borrowed time series data set, which can maximize the data between time series and nonlinearity relationship [17–20]. LSTM makes the information selectively affect the state of each moment in the model by adding a gate structure, which is mainly composed of input gate, output gate, and forgetting gate. The basic structure of the LSTM unit is shown in Figure 1.

Assuming that the input sequence is $[x_1, x_2, \cdots, x_t]$, and the hidden layer state is $[h_1, h_2, \cdots, h_t]$, then there is the following mathematical expression at time t.

2.1.1. Forgetting Gate Operation. In LSTM, a certain probability is used to control whether to forget the hidden cell state passed to the previous layer, and the sigmoid function is used to control the output range between [0, 1]. Equation (1) displays the details:

$$f_t^l = \sigma\left(W_f^l \cdot \left[h_t^{l-1}, x_t^{l-1}\right] + b_t^l\right), \tag{1}$$

where σ is the activation function; $\cdot$ represents the vector inner product; t represents the time; l represents the number of layers of the LSTM; f represents the forget gate; w represents the weight; b represents the bias; and h represents the cell output.

2.1.2. Input Gate Operation. The input gate consists of two parts. The sigmoid and tanh activation functions are used to control the range of the output value, and the product of the two parts is used to participate in the update of the cell state. Equations (2) and (3) show the details:

$$g_t^l = \sigma\left(W_g^l \cdot \left[h_{t-1}^l, x_t^{l-1}\right] + b_g^l\right), \tag{2}$$

$$\tilde{c}_t^l = \tanh\left(W_c^l \cdot \left[h_{t-1}^l, x_t^{l-1}\right] + b_c^l\right). \tag{3}$$

In the above equations, tanh() represents the activation function; g represents the input gate; c represents the cell state; and $\tilde{c}$ represents the current input cell state.

2.1.3. Cell State Update. The cell state is updated by calculating the product of the cell state at the previous moment, the output of the forget gate, and the product of the two parts of the input gate. The products of the two parts are added to update the cell state:

$$c_t^l = f_t^l * h_{t-1}^l + g_t^l * \tilde{c}_t^l, \tag{4}$$

where $*$ represents the multiplication of elements of the corresponding dimension of the two vectors.

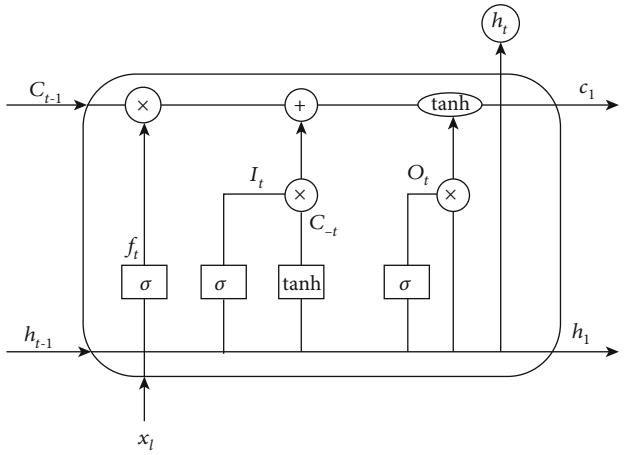

Figure 1: Basic structure of LSTM.

2.1.4. Output Gate Operation. The output gate consists of two parts. The first part also uses the hidden state at the previous moment and the input variable at this moment as input, and the output range is controlled by the sigmoid function. The second part uses the hidden state to control the output through the tanh activation function, which is multiplied with the output result of the first part to update the hidden state:

$$o_t^l = \sigma\left(W_o^l \cdot \left[h_{t-1}^l, x_t^{l-1}\right] + b_o^l\right), \tag{5}$$

$$h_t^l = h_t^l \cdot \tanh c_t^l, \tag{6}$$

where o represents the output gate.

2.2. DAE. DAE is composed of a stack of multiple sparse autoencoders. The sparse autoencoder draws on the neuron excitability mechanism of the brain. After encoding, the original data can be decoded to the maximum extent, and it also has the advantages of fast convergence speed and avoiding falling into local minima and other advantages [14–16]. The basic structure of DAE is shown in Figure 2.

The stacked autoencoder adopts a layer-by-layer greedy learning method, taking the hidden layer of the trained first sparse autoencoder as the input of the second sparse autoencoder. The hidden layer of the second sparse autoencoder is also used as the input. The input of the next sparse autoencoder is to train the sparse autoencoder in turn, and the hidden layer data of the last sparse autoencoder is used as the output of the entire stack autoencoder network. In general, the hidden layer data of each sparse autoencoder can be regarded as a potential feature of the original training data. Through this feature, the feature information contained in the original data can be decoded to the greatest extent. Therefore, multiple sparse autoencoders can be regarded as a process of extracting high-dimensional latent features of the original data.

The sparse autoencoder controls the complexity of the model by optimizing the weights and the average activation of neurons in the hidden layer to reduce network overfitting.

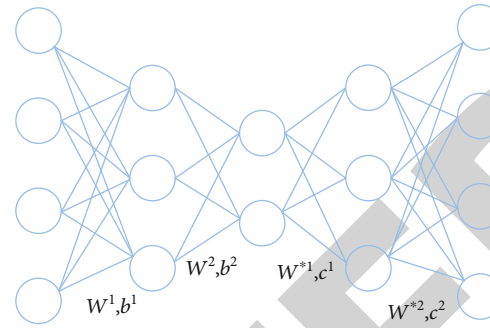

Figure 2: Basic structure of DAE.

It can be realized by adding L2 regularization term and sparse term to its cost function:

$$C = \frac{1}{N}\sum_{n=1}^{N}\sum_{k=1}^{K}\left(x_{kn} - \hat{x}_{kn}\right)^2 + \lambda \cdot \Omega_{\text{weight}} + \beta \cdot \Omega_{\text{sparsity}}, \tag{7}$$

where x_{kn} is the input sample data; $\hat{x}_{kn}$ is the actual output value; Ω_{weight} and Ω_{sparsity} are the L2 regularization term and the sparse term, respectively; λ and β are the coefficients of the L2 regularization term and the sparse term, respectively; N is the total number of samples; and K is the length of the input signal.

The essence of L2 regularization is the penalty on the weight vector, which can suppress the larger value in the weight and make the network tend to learn the smaller weight:

$$\Omega_{\text{weight}} = \frac{1}{2}\sum_{l}^{L}\sum_{j}^{n}\sum_{i}^{k}\left(w_{ji}^{(l)}\right)^2. \tag{8}$$

The function of the sparse term is to control the activation number of hidden neurons. Generally, if the output of a neuron is close to 1, the neuron is considered to be activated. Otherwise, if the output is 0, it is considered to be inhibited. The purpose of sparse autoencoders is to keep these neurons inactive most of the time. Assuming that $z_i(x_j)$ is the ith activation unit of the hidden layer during the forward propagation process, the activation unit of the hidden layer can be expressed as $h(w_i^{\mathrm{T}} + b_i)$, in which w is the weight matrix connecting the input layer and the hidden layer, and b is the offset between the two layers. Then, the hidden layer average activation of the ith unit is as follows:

$$\hat{\rho}_i = \frac{1}{n}\sum_{j=1}^{n} z_i\left(x_j\right) = \frac{1}{n}\sum_{j=1}^{n} h\left(w_i^{\mathrm{T}} + b_i\right). \tag{9}$$

Since sparsity requires most neurons to be suppressed, it is hoped that the average activation $\hat{\rho}_i$ is close to a constant ρ approximately 0, which is the sparsity parameter. In order to achieve such a sparsity effect, an additional penalty term is added to the cost function to make the average activation $\hat{\rho}_i$ not deviate from the sparsity parameter ρ. Accordingly, the

Kullback-Leibler (KL) divergence is chosen to achieve the purpose of punishment. The sparse regularization term can be expressed as follows:

$$\Omega_{\text{sparsity}} = \sum_{i=1}^{D} KL(\rho \| \widehat{\rho}_i) = \sum_{i=1}^{D} \rho \log\left(\frac{\rho}{\rho_i}\right) + (1-\rho)\log\left(\frac{1-\rho}{1-\rho_i}\right). \tag{10}$$

In Equation (10), D is the number of hidden layer units. If $\widehat{\rho}_i = \rho$, then $KL(\rho \| \widehat{\rho}_i) = 0$.

To sum up, the cost function of sparse autoencoder can be expressed as follows:

$$C = \frac{1}{N}\sum_{n=1}^{N}\sum_{k=1}^{K}(x_{kn} - \widehat{x}_{kn})^2 + \frac{\lambda}{2}\sum_{l}^{L}\sum_{j}^{n}\sum_{i}^{k}\left(w_{ji}^{(l)}\right)^2 + \beta\sum_{i=1}^{D} KL(\rho \| \widehat{\rho}_i). \tag{11}$$

Finally, the entire network obtains the optimized weights w and bias b through the back-propagation algorithm.

2.3. Book Recommendation Model. In order to model the temporal sequence of the user's book borrowing data, LSTM is used to replace the feedforward neural network in DAE, and the two are combined. The basic process of the proposed method is shown in Figure 3. The time series feature extraction method proposed in this paper includes five parts: input layer, encoding layer, LSTM layer, decoding layer, and output layer. First, the input data is preprocessed, including data enhancement and sequence division by window. And then each sequence is sent to the encoder to obtain a feature vector, which is then used as the input of the LSTM network. Finally, the output of the LSTM is sent to the decoder to obtain a reconstruction of the next window of the original data window. The training process is performed by minimizing the reconstruction error. And after the training is completed, the LSTM network output is extracted as the extracted time series features. After the time series features of the data are extracted in the previous step, the output of the LSTM is used as the input, and the final recommendation result of the model is obtained through the Softmax function.

3. Experiment and Analysis

3.1. Sample Set and Preprocessing. A real data set of a library is used, which contains 342,451 book loan records, including 4,652 users and 6,783 books. Each record contains attributes such as user id, borrowing time, book id, book name, and book category.

Step 1: The original data is simplified into triples (user id, course selection time, and course id)

Step 2: From the 4652 users, the users who have borrowed less than 5 books are removed, leaving 184201 pieces of data and 3347 users

Step 3: According to the user grouping, it is divided into 2675 groups. In each group, the books are sorted in ascending order according to the time of borrowing books

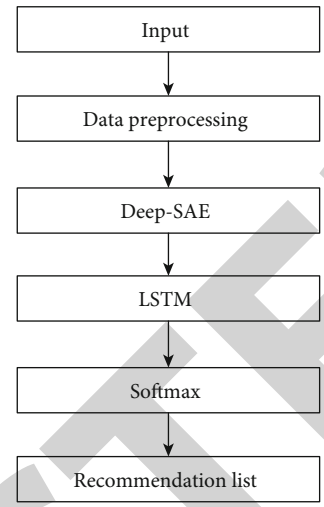

Figure 3: Basic procedure of book recommendation model.

Step 4: The data in the group is merged according to (user id, book id time series) to get the final data set, which contains a total of 3789 pieces of data

3.2. Evaluation Index. In this paper, three evaluation indexes commonly used in Top-N recommender systems, i.e., precision (P), recall (R), and F_1 score (F_1), are used to measure the recommendation performance of the proposed method, which are calculated as follows:

$$\begin{aligned} P &= \frac{\sum_{u\in U}|R(u)\cap T(u)|}{\sum_{u\in U}|R(u)|}, \\ P &= \frac{\sum_{u\in U}|R(u)\cap T(u)|}{\sum_{u\in U}|T(u)|}, \\ F_1 &= \frac{2\times P\times R}{P+R}. \end{aligned} \tag{12}$$

where $R(u)$ represents the book recommendation list made to the user based on the book borrowing data on the training data set and $T(u)$ represents the user's book borrowing list on the test data set.

3.3. Result and Analysis. For the Top-N recommendation problem, this paper takes 3 groups of comparative experiments at $N \in \{1, 5, 10\}$. In each group of comparative experiments, the CF, autoencoder (AE), and LSTM methods in the existing methods are selected for comparison. Among them, the LSTM method only uses LSTM for recommendation, and no other deep learning models are introduced.

Tables 1, 2, and 3 show the performance comparison of various methods under different recommendation numbers. Under the same conditions, the proposed method outperforms the three comparison algorithms in terms of P, R, and F_1. In particular, compared with LSTM, this paper further improves the recommendation performance by incorporating DAE, demonstrating the effectiveness of the model. The experimental results show that the performance of the recommendation algorithm based on the deep

Table 1: Comparison of different methods at $N = 1$.

Method	P	R	F_1
Proposed	0.172	0.158	0.164
CF	0.147	0.141	0.145
AE	0.156	0.152	0.154
LSTM	0.163	0.158	0.160

Table 2: Comparison of different methods at $N = 5$.

Method	P	R	F_1
Proposed	0.398	0.382	0.387
CF	0.356	0.348	0.361
AE	0.369	0.354	0.363
LSTM	0.378	0.365	0.371

Table 3: Comparison of different methods at $N = 10$.

Method	P	R	F_1
Proposed	0.543	0.528	0.532
CF	0.497	0.482	0.488
AE	0.518	0.503	0.508
LSTM	0.524	0.516	0.519

learning is better than that of the traditional algorithms, because the deep learning algorithm can extract deeper data features. The method proposed in this paper uses DAE for deep feature extraction and applies LSTM to model the time series features of the data, so the final overall performance is further improved.

Comparing the results under different recommended numbers, it can be seen that with the increase of N, the three performance evaluation indexes of various methods are also getting higher and higher. The probability is also increasing. Compared with various methods, the improvement of the method in this paper is more significant, which further reflects its effectiveness.

4. Conclusion

This paper proposes a recommendation model based on DAE and LSTM for the personalized book recommendation problem in university libraries. First, LSTM is used to improve the DAE so that the model can extract the temporal characteristics of the data. The Softmax is used for the direct recommendation of books for the users. Finally, the experimental verification is carried out on the real library lending data set. The experimental results show that the proposed method has higher accuracy compared with several existing recommendation algorithms. Therefore, the method in this paper can be applied in subsequent library lending systems to enhance overall work efficiency.

Data Availability

The data set can be accessed upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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