

Intelligent Caching for Communication and Security of Smart Grid Networks

Lead Guest Editor: Tao Cui

Guest Editors: Muhammad Ahmad and Nan Zhang





Intelligent Caching for Communication and Security of Smart Grid Networks

Security and Communication Networks

Intelligent Caching for Communication and Security of Smart Grid Networks

Lead Guest Editor: Tao Cui

Guest Editors: Muhammad Ahmad and Nan Zhang





Copyright © 2023 Hindawi Limited. All rights reserved.

This is a special issue published in "Security and Communication Networks." All articles are open access articles distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Chief Editor

Roberto Di Pietro, Saudi Arabia

Associate Editors

Jiankun Hu , Australia
Emanuele Maiorana , Italy
David Megias , Spain
Zheng Yan , China

Academic Editors

Saed Saleh Al Rabae , United Arab Emirates
Shadab Alam, Saudi Arabia
Goutham Reddy Alavalapati , USA
Jehad Ali , Republic of Korea
Jehad Ali, Saint Vincent and the Grenadines
Benjamin Aziz , United Kingdom
Taimur Bakhshi , United Kingdom
Spiridon Bakiras , Qatar
Musa Balta, Turkey
Jin Wook Byun , Republic of Korea
Bruno Carpentieri , Italy
Luigi Catuogno , Italy
Ricardo Chaves , Portugal
Chien-Ming Chen , China
Tom Chen , United Kingdom
Stelvio Cimato , Italy
Vincenzo Conti , Italy
Luigi Coppolino , Italy
Salvatore D'Antonio , Italy
Juhriyansyah Dalle, Indonesia
Alfredo De Santis, Italy
Angel M. Del Rey , Spain
Roberto Di Pietro , France
Wenxiu Ding , China
Nicola Dragoni , Denmark
Wei Feng , China
Carmen Fernandez-Gago, Spain
AnMin Fu , China
Clemente Galdi , Italy
Dimitrios Geneiatakis , Italy
Muhammad A. Gondal , Oman
Francesco Gringoli , Italy
Biao Han , China
Jinguang Han , China
Khizar Hayat, Oman
Azeem Irshad, Pakistan

M.A. Jabbar , India
Minho Jo , Republic of Korea
Arijit Karati , Taiwan
ASM Kayes , Australia
Farrukh Aslam Khan , Saudi Arabia
Fazlullah Khan , Pakistan
Kiseon Kim , Republic of Korea
Mehmet Zeki Konyar, Turkey
Sanjeev Kumar, USA
Hyun Kwon, Republic of Korea
Maryline Laurent , France
Jegatha Deborah Lazarus , India
Huaizhi Li , USA
Jiguo Li , China
Xueqin Liang, Finland
Zhe Liu, Canada
Guangchi Liu , USA
Flavio Lombardi , Italy
Yang Lu, China
Vincente Martin, Spain
Weizhi Meng , Denmark
Andrea Michienzi , Italy
Laura Mongioi , Italy
Raul Monroy , Mexico
Naghme Moradpoor , United Kingdom
Leonardo Mostarda , Italy
Mohamed Nassar , Lebanon
Qiang Ni, United Kingdom
Mahmood Niazi , Saudi Arabia
Vincent O. Nyangaresi, Kenya
Lu Ou , China
Hyun-A Park, Republic of Korea
A. Peinado , Spain
Gerardo Pelosi , Italy
Gregorio Martinez Perez , Spain
Pedro Peris-Lopez , Spain
Carla Ràfols, Germany
Francesco Regazzoni, Switzerland
Abdalhossein Rezai , Iran
Helena Rifà-Pous , Spain
Arun Kumar Sangaiah, India
Nadeem Sarwar, Pakistan
Neetesh Saxena, United Kingdom
Savio Sciancalepore , The Netherlands

De Rosal Ignatius Moses Setiadi ,
Indonesia
Wenbo Shi, China
Ghanshyam Singh , South Africa
Vasco Soares, Portugal
Salvatore Sorce , Italy
Abdulhamit Subasi, Saudi Arabia
Zhiyuan Tan , United Kingdom
Keke Tang , China
Je Sen Teh , Australia
Bohui Wang, China
Guojun Wang, China
Jinwei Wang , China
Qichun Wang , China
Hu Xiong , China
Chang Xu , China
Xuehu Yan , China
Anjia Yang , China
Jiachen Yang , China
Yu Yao , China
Yinghui Ye, China
Kuo-Hui Yeh , Taiwan
Yong Yu , China
Xiaohui Yuan , USA
Sherali Zeadally, USA
Leo Y. Zhang, Australia
Tao Zhang, China
Youwen Zhu , China
Zhengyu Zhu , China

Contents

Retracted: Ecological Concept of Basic Computer Vision and Visual Communication of Advertising under the Concept of Ecological Design

Security and Communication Networks

Retraction (1 page), Article ID 9896346, Volume 2023 (2023)

Retracted: Adaptive Control Strategy of Multiemergency Power Supply Network System Connected to New Energy

Security and Communication Networks

Retraction (1 page), Article ID 9894101, Volume 2023 (2023)

Retracted: A Study on Urban Spatial System Planning of Qingdao City Park Based on Intelligent Monitoring Sensors

Security and Communication Networks

Retraction (1 page), Article ID 9891626, Volume 2023 (2023)

Retracted: The Impact of Intelligent Accounting Information Management on Corporate Governance Information Transparency

Security and Communication Networks

Retraction (1 page), Article ID 9870610, Volume 2023 (2023)

Retracted: A Grey Prediction Algorithm for Enterprise Human Resource Management Validity Model Construction and Improvement

Security and Communication Networks

Retraction (1 page), Article ID 9864971, Volume 2023 (2023)

Retracted: Research on Fuzzy Control Method of Automobile Antilock Braking System

Security and Communication Networks

Retraction (1 page), Article ID 9861525, Volume 2023 (2023)

Retracted: Construction of Digital Marketing Recommendation Model Based on Random Forest Algorithm

Security and Communication Networks

Retraction (1 page), Article ID 9837989, Volume 2023 (2023)

Retracted: Exploratory Research on the Practice of College English Classroom Teaching Based on Internet and Artificial Intelligence

Security and Communication Networks

Retraction (1 page), Article ID 9834514, Volume 2023 (2023)

Retracted: Application Research of Fuzzy Control Comprehensive Model in Agricultural Economic Management

Security and Communication Networks

Retraction (1 page), Article ID 9823928, Volume 2023 (2023)

Retracted: A Low-Latency and High-Throughput Multipath Technique to Overcome Black Hole Attack in Mobile Ad Hoc Network (MTBD)

Security and Communication Networks

Retraction (1 page), Article ID 9808670, Volume 2023 (2023)

Retracted: Data File Security Strategy and Implementation Based on Fuzzy Control Algorithm

Security and Communication Networks

Retraction (1 page), Article ID 9796439, Volume 2023 (2023)

Retracted: Green City Landscape Design Based on GIS System

Security and Communication Networks

Retraction (1 page), Article ID 9763604, Volume 2023 (2023)

Retracted: Analysis of the Structure of Aerobics Complete Sets of Movements Based on Genetic Algorithm

Security and Communication Networks

Retraction (1 page), Article ID 9762514, Volume 2023 (2023)

Retracted: Artificial Intelligence-Based Online Education System for University Music

Security and Communication Networks

Retraction (1 page), Article ID 9762569, Volume 2023 (2023)

Retracted: Construction of Multimedia English Teaching Resource Base Based on K-Means Clustering Algorithm

Security and Communication Networks

Retraction (1 page), Article ID 9754542, Volume 2023 (2023)

Retracted: Research on the Application of Improved K-Means Spatial Clustering Algorithm in Landscape Conservation of Gardens

Security and Communication Networks

Retraction (1 page), Article ID 9876570, Volume 2023 (2023)

Retracted: Piano Teaching Improvement Based on Machine Learning and Artificial Intelligence

Security and Communication Networks

Retraction (1 page), Article ID 9869236, Volume 2023 (2023)

Retracted: On the Design of Assistant Teaching Using Network Multimedia Database in Volleyball Teaching

Security and Communication Networks

Retraction (1 page), Article ID 9863171, Volume 2023 (2023)

Retracted: Prediction of Higher Education Cost and Analysis of Sharing Ability Based on Artificial Neural Network

Security and Communication Networks

Retraction (1 page), Article ID 9823698, Volume 2023 (2023)

Contents

Retracted: A Deep Learning-Based Assisted Teaching System for Oral English

Security and Communication Networks

Retraction (1 page), Article ID 9821752, Volume 2023 (2023)

Retracted: Analysis of Legal Issues of the Crime of Endangering Public Safety Based on Data Mining Algorithm

Security and Communication Networks

Retraction (1 page), Article ID 9813851, Volume 2023 (2023)

Retracted: A Study of the Morphological Design of Architecture from a Geometric Logic Perspective

Security and Communication Networks

Retraction (1 page), Article ID 9804284, Volume 2023 (2023)

Retracted: Image Processing Based on Fuzzy Mathematics Theory

Security and Communication Networks

Retraction (1 page), Article ID 9794514, Volume 2023 (2023)

Retracted: The Validity of Marketing Strategy of Tourist Attractions Based on Experiential Marketing

Security and Communication Networks

Retraction (1 page), Article ID 9764784, Volume 2023 (2023)

[Retracted] A Study on Urban Spatial System Planning of Qingdao City Park Based on Intelligent Monitoring Sensors

Jie Luo, Xiao Wang, Yang Zhao, Ling Meng, Yuemei Gou, Yingdong Yuan, Jie Sun , and Na Qin 

Research Article (13 pages), Article ID 8932773, Volume 2022 (2022)

[Retracted] Analysis of Legal Issues of the Crime of Endangering Public Safety Based on Data Mining Algorithm

Yaqiong Xu and Tao Feng 


Research Article (12 pages), Article ID 4794752, Volume 2022 (2022)

[Retracted] Prediction of Higher Education Cost and Analysis of Sharing Ability Based on Artificial Neural Network

Zilong Xia, Xin Yue, FanChao Niu, and Zhihua Hu 


Research Article (11 pages), Article ID 7649918, Volume 2022 (2022)

[Retracted] Adaptive Control Strategy of Multiemergency Power Supply Network System Connected to New Energy

Wei Zhang , Ming Zhong, Minfu A, Yumei Sun, and Yang Wang


Research Article (11 pages), Article ID 5733358, Volume 2022 (2022)

[Retracted] Ecological Concept of Basic Computer Vision and Visual Communication of Advertising under the Concept of Ecological Design

Ao Zhang and Jin Wenyue 


Research Article (11 pages), Article ID 8392918, Volume 2022 (2022)

[Retracted] On the Design of Assistant Teaching Using Network Multimedia Database in Volleyball Teaching

Juan Yin  and Qingyao Song


Research Article (10 pages), Article ID 8684007, Volume 2022 (2022)

[Retracted] A Deep Learning-Based Assisted Teaching System for Oral English

Haibo Li and Xue Liu 


Research Article (10 pages), Article ID 1882662, Volume 2022 (2022)

[Retracted] Research on the Application of Improved K-Means Spatial Clustering Algorithm in Landscape Conservation of Gardens

Hao Sun  and Yuanyuan Yang

Research Article (11 pages), Article ID 3148223, Volume 2022 (2022)

[Retracted] A Study of the Morphological Design of Architecture from a Geometric Logic Perspective

Liuzhen Zhao and Yingli Yang 


Research Article (11 pages), Article ID 8140350, Volume 2022 (2022)

[Retracted] Data File Security Strategy and Implementation Based on Fuzzy Control Algorithm

Jin Ren 








Research Article (10 pages), Article ID 2010419, Volume 2022 (2022)

[Retracted] Construction of Multimedia English Teaching Resource Base Based on K-Means Clustering Algorithm

Jinyan Yan , Lianfang Wu, and Qinghong Wang

Research Article (12 pages), Article ID 4397617, Volume 2022 (2022)

[Retracted] A Low-Latency and High-Throughput Multipath Technique to Overcome Black Hole Attack in Mobile Ad Hoc Network (MTBD)

Dhanagopal Ramachandran , Sasikumar S , Vallabhuni Rajeev Ratna , Vijayprasath S , Suresh Kumar R , Vasanth Raj P T , Ilhan Garip, and Umamaheswari K 


Research Article (13 pages), Article ID 8067447, Volume 2022 (2022)

[Retracted] Artificial Intelligence-Based Online Education System for University Music

Yi Xie 


Research Article (13 pages), Article ID 5842900, Volume 2022 (2022)

[Retracted] Piano Teaching Improvement Based on Machine Learning and Artificial Intelligence

Nan Zhang 

Research Article (11 pages), Article ID 9672068, Volume 2022 (2022)

[Retracted] Image Processing Based on Fuzzy Mathematics Theory

Maowen Hou 

Research Article (10 pages), Article ID 5287025, Volume 2022 (2022)


Contents

[Retracted] Analysis of the Structure of Aerobics Complete Sets of Movements Based on Genetic Algorithm

Huiyun Yang, Feng Miao , and Xue Deng

Research Article (9 pages), Article ID 9063568, Volume 2022 (2022)

[Retracted] Construction of Digital Marketing Recommendation Model Based on Random Forest Algorithm

Weiji Gao , and Zihua Ding

Research Article (9 pages), Article ID 1871060, Volume 2022 (2022)

[Retracted] Green City Landscape Design Based on GIS System

Yanlan Liang and Huijing Wang 



Research Article (10 pages), Article ID 5155677, Volume 2022 (2022)

[Retracted] Application Research of Fuzzy Control Comprehensive Model in Agricultural Economic Management

Juan Huang , Ru Guo, and Xiaosen Wen


Research Article (11 pages), Article ID 4406336, Volume 2022 (2022)

[Retracted] The Validity of Marketing Strategy of Tourist Attractions Based on Experiential Marketing

Mei Song , Tianjiao Niu, Linna Wang, and Xiaoyi Wang 


Research Article (10 pages), Article ID 1825171, Volume 2022 (2022)

[Retracted] Exploratory Research on the Practice of College English Classroom Teaching Based on Internet and Artificial Intelligence

Yunjie Jia 

Research Article (9 pages), Article ID 7133654, Volume 2022 (2022)

[Retracted] A Grey Prediction Algorithm for Enterprise Human Resource Management Validity Model Construction and Improvement

Yajing Yang 


Research Article (11 pages), Article ID 2023610, Volume 2022 (2022)

[Retracted] Research on Fuzzy Control Method of Automobile Antilock Braking System

Qiang Fu 

Research Article (9 pages), Article ID 5001185, Volume 2022 (2022)

[Retracted] The Impact of Intelligent Accounting Information Management on Corporate Governance Information Transparency

Baiyu He 

Research Article (13 pages), Article ID 2478926, Volume 2022 (2022)

Retraction

Retracted: Ecological Concept of Basic Computer Vision and Visual Communication of Advertising under the Concept of Ecological Design

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. Zhang and J. Wenyue, "Ecological Concept of Basic Computer Vision and Visual Communication of Advertising under the Concept of Ecological Design," *Security and Communication Networks*, vol. 2022, Article ID 8392918, 11 pages, 2022.

Retraction

Retracted: Adaptive Control Strategy of Multiemergency Power Supply Network System Connected to New Energy

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. Zhang, M. Zhong, M. A. Y. Sun, and Y. Wang, "Adaptive Control Strategy of Multiemergency Power Supply Network System Connected to New Energy," *Security and Communication Networks*, vol. 2022, Article ID 5733358, 11 pages, 2022.

Retraction

Retracted: A Study on Urban Spatial System Planning of Qingdao City Park Based on Intelligent Monitoring Sensors

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. Luo, X. Wang, Y. Zhao et al., "A Study on Urban Spatial System Planning of Qingdao City Park Based on Intelligent Monitoring Sensors," *Security and Communication Networks*, vol. 2022, Article ID 8932773, 13 pages, 2022.

Retraction

Retracted: The Impact of Intelligent Accounting Information Management on Corporate Governance Information Transparency

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. He, "The Impact of Intelligent Accounting Information Management on Corporate Governance Information Transparency," *Security and Communication Networks*, vol. 2022, Article ID 2478926, 13 pages, 2022.

Retraction

Retracted: A Grey Prediction Algorithm for Enterprise Human Resource Management Validity Model Construction and Improvement

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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] Y. Yang, "A Grey Prediction Algorithm for Enterprise Human Resource Management Validity Model Construction and Improvement," *Security and Communication Networks*, vol. 2022, Article ID 2023610, 11 pages, 2022.

Retraction

Retracted: Research on Fuzzy Control Method of Automobile Antilock Braking System

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. Fu, "Research on Fuzzy Control Method of Automobile Antilock Braking System," *Security and Communication Networks*, vol. 2022, Article ID 5001185, 9 pages, 2022.

Retraction

Retracted: Construction of Digital Marketing Recommendation Model Based on Random Forest Algorithm

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. Gao and Z. Ding, "Construction of Digital Marketing Recommendation Model Based on Random Forest Algorithm," *Security and Communication Networks*, vol. 2022, Article ID 1871060, 9 pages, 2022.

Retraction

Retracted: Exploratory Research on the Practice of College English Classroom Teaching Based on Internet and Artificial Intelligence

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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] Y. Jia, "Exploratory Research on the Practice of College English Classroom Teaching Based on Internet and Artificial Intelligence," *Security and Communication Networks*, vol. 2022, Article ID 7133654, 9 pages, 2022.

Retraction

Retracted: Application Research of Fuzzy Control Comprehensive Model in Agricultural Economic Management

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. Huang, R. Guo, and X. Wen, "Application Research of Fuzzy Control Comprehensive Model in Agricultural Economic Management," *Security and Communication Networks*, vol. 2022, Article ID 4406336, 11 pages, 2022.

Retraction

Retracted: A Low-Latency and High-Throughput Multipath Technique to Overcome Black Hole Attack in Mobile Ad Hoc Network (MTBD)

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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] D. Ramachandran, S. S. V. Rajeev Ratna et al., “A Low-Latency and High-Throughput Multipath Technique to Overcome Black Hole Attack in Mobile Ad Hoc Network (MTBD),” *Security and Communication Networks*, vol. 2022, Article ID 8067447, 13 pages, 2022.

Retraction

Retracted: Data File Security Strategy and Implementation Based on Fuzzy Control Algorithm

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. Ren, "Data File Security Strategy and Implementation Based on Fuzzy Control Algorithm," *Security and Communication Networks*, vol. 2022, Article ID 2010419, 10 pages, 2022.

Retraction

Retracted: Green City Landscape Design Based on GIS System

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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] Y. Liang and H. Wang, "Green City Landscape Design Based on GIS System," *Security and Communication Networks*, vol. 2022, Article ID 5155677, 10 pages, 2022.

Retraction

Retracted: Analysis of the Structure of Aerobics Complete Sets of Movements Based on Genetic Algorithm

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. Yang, F. Miao, and X. Deng, "Analysis of the Structure of Aerobics Complete Sets of Movements Based on Genetic Algorithm," *Security and Communication Networks*, vol. 2022, Article ID 9063568, 9 pages, 2022.

Retraction

Retracted: Artificial Intelligence-Based Online Education System for University Music

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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] Y. Xie, "Artificial Intelligence-Based Online Education System for University Music," *Security and Communication Networks*, vol. 2022, Article ID 5842900, 13 pages, 2022.

Retraction

Retracted: Construction of Multimedia English Teaching Resource Base Based on *K*-Means Clustering Algorithm

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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] J. Yan, L. Wu, and Q. Wang, "Construction of Multimedia English Teaching Resource Base Based on *K*-Means Clustering Algorithm," *Security and Communication Networks*, vol. 2022, Article ID 4397617, 12 pages, 2022.

Retraction

Retracted: Research on the Application of Improved K-Means Spatial Clustering Algorithm in Landscape Conservation of Gardens

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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] H. Sun and Y. Yang, "Research on the Application of Improved K-Means Spatial Clustering Algorithm in Landscape Conservation of Gardens," *Security and Communication Networks*, vol. 2022, Article ID 3148223, 11 pages, 2022.

Retraction

Retracted: Piano Teaching Improvement Based on Machine Learning and Artificial Intelligence

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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.

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] N. Zhang, "Piano Teaching Improvement Based on Machine Learning and Artificial Intelligence," *Security and Communication Networks*, vol. 2022, Article ID 9672068, 11 pages, 2022.

Retraction

Retracted: On the Design of Assistant Teaching Using Network Multimedia Database in Volleyball Teaching

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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.

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] J. Yin and Q. Song, "On the Design of Assistant Teaching Using Network Multimedia Database in Volleyball Teaching," *Security and Communication Networks*, vol. 2022, Article ID 8684007, 10 pages, 2022.

Retraction

Retracted: Prediction of Higher Education Cost and Analysis of Sharing Ability Based on Artificial Neural Network

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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] Z. Xia, X. Yue, F. Niu, and Z. Hu, "Prediction of Higher Education Cost and Analysis of Sharing Ability Based on Artificial Neural Network," *Security and Communication Networks*, vol. 2022, Article ID 7649918, 11 pages, 2022.

Retraction

Retracted: A Deep Learning-Based Assisted Teaching System for Oral English

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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] H. Li and X. Liu, "A Deep Learning-Based Assisted Teaching System for Oral English," *Security and Communication Networks*, vol. 2022, Article ID 1882662, 10 pages, 2022.

Retraction

Retracted: Analysis of Legal Issues of the Crime of Endangering Public Safety Based on Data Mining Algorithm

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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] Y. Xu and T. Feng, "Analysis of Legal Issues of the Crime of Endangering Public Safety Based on Data Mining Algorithm," *Security and Communication Networks*, vol. 2022, Article ID 4794752, 12 pages, 2022.

Retraction

Retracted: A Study of the Morphological Design of Architecture from a Geometric Logic Perspective

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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] L. Zhao and Y. Yang, "A Study of the Morphological Design of Architecture from a Geometric Logic Perspective," *Security and Communication Networks*, vol. 2022, Article ID 8140350, 11 pages, 2022.

Retraction

Retracted: Image Processing Based on Fuzzy Mathematics Theory

Security and Communication Networks

Received 19 September 2023; Accepted 19 September 2023; Published 20 September 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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] M. Hou, "Image Processing Based on Fuzzy Mathematics Theory," *Security and Communication Networks*, vol. 2022, Article ID 5287025, 10 pages, 2022.

Retraction

Retracted: The Validity of Marketing Strategy of Tourist Attractions Based on Experiential Marketing

Security and Communication Networks

Received 19 September 2023; Accepted 19 September 2023; Published 20 September 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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.

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] M. Song, T. Niu, L. Wang, and X. Wang, "The Validity of Marketing Strategy of Tourist Attractions Based on Experiential Marketing," *Security and Communication Networks*, vol. 2022, Article ID 1825171, 10 pages, 2022.

Retraction

Retracted: A Study on Urban Spatial System Planning of Qingdao City Park Based on Intelligent Monitoring Sensors

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. Luo, X. Wang, Y. Zhao et al., "A Study on Urban Spatial System Planning of Qingdao City Park Based on Intelligent Monitoring Sensors," *Security and Communication Networks*, vol. 2022, Article ID 8932773, 13 pages, 2022.

Research Article

A Study on Urban Spatial System Planning of Qingdao City Park Based on Intelligent Monitoring Sensors

Jie Luo,¹ Xiao Wang,² Yang Zhao,¹ Ling Meng,¹ Yuemei Gou,¹ Yingdong Yuan,³ Jie Sun ,⁴ and Na Qin ⁵

¹Qingdao School of Landscape and Forestry Technology, Qingdao, Shandong 26600, China

²Qingdao Laoying Haina Opto-Electronic Environmental Protection Group Co., Ltd, Qingdao, Shandong 26600, China

³Qingdao Municipal Engineering Design & Research Institute, Qingdao, Shandong 26600, China

⁴Quality and Safety Supervision Station of Qingdao Landscaping Project, Qingdao, Shandong 26600, China

⁵Qingdao Landscape Architecture Design Planning Co., Ltd, Qingdao, Shandong 26600, China

Correspondence should be addressed to Jie Sun; sj18669726677@126.com and Na Qin; qinna19771977@163.com

Received 16 June 2022; Revised 18 July 2022; Accepted 29 July 2022; Published 21 September 2022

Academic Editor: Tao Cui

Copyright © 2022 Jie Luo et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Since the release of the 13th Five-Year Plan, the construction plan of the smart city and Internet of Things (IoT) has once again pushed the sensors into the limelight. In the current situation, whether in China or around the world, the construction of smart communities has become an irreversible trend. In this environment, the sensor as a smart city “bridge” will certainly usher in an industrial explosion. “Smart city” is a new concept and model for urban development. Academics have also explored the concept and theoretical model of smart cities from different perspectives in different forms. With the gradual establishment of the national smart city system, the Internet of Things and other technologies are being widely used to serve other aspects of human social life, such as urban smart communities, intelligent transportation, and intelligent home security systems. The application of technology is gradually penetrating into the life of our human society. In the context of building a smart city, scholars have also brought an unprecedented broader idea. By seeking a reasonable balance between human and urban nature, the concept of “park city,” which aims to create a good ecological habitat where people and nature can coexist and develop in harmony, has emerged as China’s urbanization process accelerates and the conflict between people and land becomes more and more prominent. As an important factor to promote the harmonious development of humans and nature, the planning and construction of urban parks is an important means to meet the needs of people for a better life and to improve the ecological environment of cities; therefore, the planning and design of urban parks under the concept of “park city” is getting more and more attention. Qingdao, as a typical coastal city, has a mosaic of green areas and urban construction land, so urban ecological parks with the carrier of nonconstruction land exist in large numbers in the city and become a key link in the practice of the “park city” concept. However, while urban ecological parks provide ecological and social services to citizens, their special land use has also led to a series of problems. At present, there is not enough basis for the planning and management of such special parks in Qingdao, and it is not possible to guide the planning and construction of such parks with universal standards, so how to effectively protect and reasonably utilize them to promote the construction of “park city” is an urgent problem to be solved. Based on the above background, this study takes Qingdao urban ecological park as the research object and summarizes the typical problems in the process of planning, construction, and use of this kind of park through relevant data research and extensive studies. Based on this, we propose three aspects, namely, the location and layout of parks at a macro level, the construction of the park system at meso-level, and the design optimization of parks at a micro level. The specific research content includes the following aspects: the first part defines the background, purpose, and significance of the topic and the research object and summarizes and reviews the existing research results at home and abroad, and then proposes the overall idea and framework of the research. The second part analyzes the problems of Qingdao urban ecological parks with the concept of “park city.” Based on the connotation and characteristics of the “park city” concept, the impact of the concept on urban parks is analyzed, and the significance of the “park city” concept on the planning and construction of urban ecological parks is clarified based on the special characteristics of urban ecological parks. Finally, we provide the basis for the proposed strategy by combining case studies at different levels. Finally, we propose a better spatial planning for the construction of a park city in Qingdao using smart detection sensors and other means of building a smart city.

1. Introduction

The rapid development of the Internet of Things, cloud computing, mobile Internet, and other technologies is constantly promoting the degree of informationization of urban construction at home and abroad; from the initial “digital city” to the “smart earth” proposed by IBM in 2008, “smart city” has attracted wide attention from all walks of life, and the construction of smart city has become a trend and research hotspot of urban development at home and abroad [1]. China’s smart city construction is ahead of the international, domestic scholars began to learn from foreign smart city construction as early as 2005 and the absorption of development experience, with Premier Wen Jiabao’s visit to Wuxi in 2009. All major cities in China have launched their smart city development strategies one after another. At present, there are 193 pilot smart cities in China. For the construction of new urbanization and smart city development, the State Council also clearly proposed to actively accelerate the development of China’s urban digital integration and management of integrated information technology; to enhance the level of capacity and comprehensive services for the national urban development of information technology integrated services management, intelligent digital urbanization will become the future of China’s smart city development of another important basic strategic state policy that will not only be the construction of green, low-carbon, and harmonious social life. Intelligent digital urbanization will become another important strategic national policy in the future development of China’s smart cities not only as an inevitable choice to build a green, low-carbon, and harmonious social lifestyle, but also as a major engine to promote the future integration of urban science and technology innovation and social and economic development in China [2].

In the rapid development of urbanization in China, the development of the city is also facing huge challenges. The successful establishment of the smart city system application and innovative development model to help China’s smart cities break through the bottleneck and bottleneck to alleviate the problems of urban development to promote the effective transformation of the urban model application and urban innovation development model proposed scientific and effective and feasible system solutions. The gradual establishment and rapid development of smart cities have also presented and given some effective and feasible specific solutions for how to deal with the various development challenges that we are currently facing in China’s smart cities [3]. In terms of social development and public services, smart cities can collect and analyze huge urban population information through the use of emerging information technologies such as the Internet of Things and cloud computing to achieve effective management of the urban mobile population, through the establishment of corresponding information platforms to achieve the sharing of various information such as labor force education and skills, helping cities to grasp the supply and demand situation of

talents, better implement urban talent strategy. By establishing a convenient and transparent public service platform for citizens, we can promote the sharing of public service information and resources and achieve a balance between supply and demand of public services. In terms of economic transformation and development, the investment and information technology application of smart cities can promote the development of strategic emerging industries including the Internet of Things, cloud computing, and the next-generation Internet, as well as the transformation and upgrading of traditional industries. By building the interconnection of various types of information and enhancing the government’s public service capacity for enterprises, it provides a more favorable external environment for urban innovation and entrepreneurship. In terms of environment and ecology, smart cities can evaluate and optimize the use of natural resources, protect, and improve the regenerative capacity of natural resources; find and control pollution flexibly and effectively through advanced monitoring means, and take effective remedial measures in a timely manner. In addition, the application of advanced information technology tools will greatly enhance the government’s urban management capabilities; the government can use intelligent technology to predict the future demand and supply of infrastructure, so as to enable reasonable planning of infrastructure construction and improve the utilization rate and operational efficiency of infrastructure, but also through intelligent infrastructure it can easily collect data to establish early warning mechanisms, rapid impact on public crises, and strengthen public safety and emergency management. It can be seen that the promotion of smart city construction brings new opportunities for China’s cities to break through development bottlenecks, solve the problems encountered in urban development, and promote urban transformation and innovative development. The relevant departments of our country and local governments attach more importance to the construction of smart cities, and the promotion and strengthening of smart city construction have important practical significance for the development of our cities.

In recent years, the construction of smart cities has received the attention and support of the national and local government departments. At present, there is a wave of smart city construction in China, and more than 250 cities in China have proposed to build smart cities [4]. In order to better promote the construction of smart cities in China, since January 2013, the Ministry of Housing and Urban-Rural Development has announced 290 pilot smart cities in three batches. In order to strengthen the guidance of smart city construction practice around China and promote the coordination of smart city construction work, in July 2013, eight ministries and commissions, including the National Development and Reform Commission, the Ministry of Industry and Information Technology, the Ministry of Science and Technology, the Ministry of Public Security, the Ministry of Finance, the Ministry of Land and Resources, the Ministry of Housing and Urban-Rural Development, and the Ministry of Transportation, jointly researched and

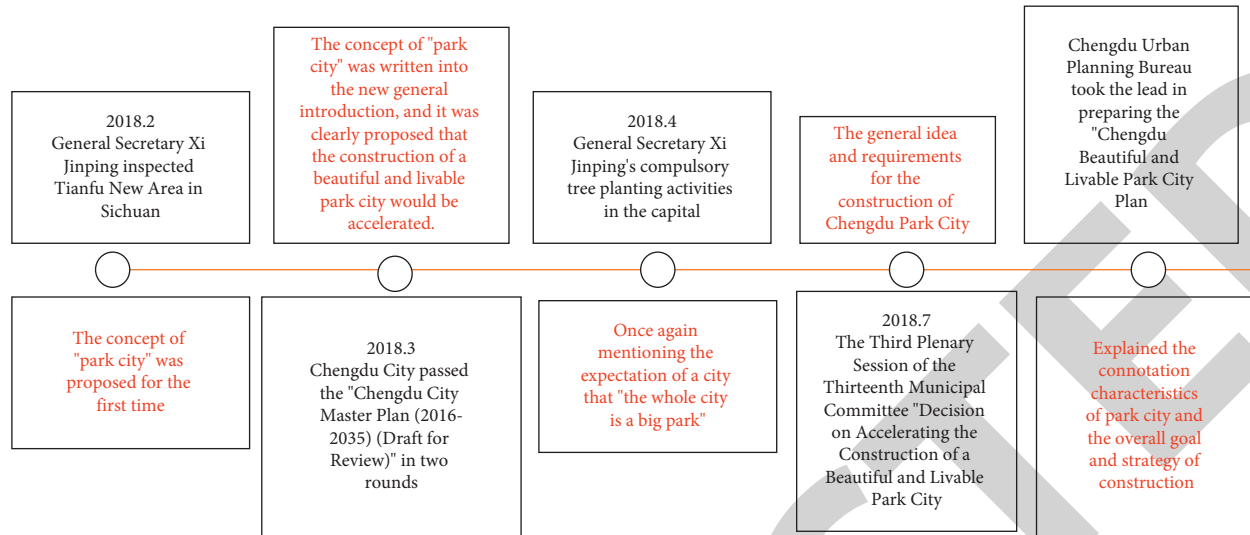


FIGURE 1: "Park City" proposed.

drafted the "Guidance on Promoting the Healthy Development of Smart Cities," which was approved by the State Council. At the same time, local governments also pay more attention to the construction of smart cities and write the construction of smart cities into the government work report or into the local "12th Five-Year Plan" [5].

In February 2018, General Secretary Xi Jinping put forward the concept of "park city" for the first time during his research in Chengdu Tianfu New Area, and emphasized that the construction should "highlight the characteristics of park city, consider the ecological value, and create a new growth pole" as a new concept of urban construction and development, which is in line with the development requirements of the times and fully reflects the ecological civilization and "people-centered" ideology. As a new concept of urban construction and development, it meets the requirements of the times, fully reflects the high degree of unity between ecological civilization and "people-centered" thinking, and pays attention to the protection of the ecological environment and urban and rural characteristics. Related practical exploration is gradually being carried out throughout the country. Since 2018, Sichuan Province has taken the lead in the construction of park cities, and relevant departments have issued documents such as "Guidance on the construction of park cities to promote high-quality urban development". Chengdu, as the first place where "park city" is proposed, has promulgated the "Chengdu City Beautiful and Livable Park City Plan (2018-2035)" and "Chengdu City Beautiful and Livable Park City Construction Regulations (Draft)," and carried out academic seminars such as the Park City Forum to accelerate the pace of construction and development of the whole area [6]. Subsequently, many cities, including Yang and Nam, carried out relevant planning studies one after another. However, because the construction standards and practices of park cities are still in the initial stage, the real meaning of park cities has not yet been built. Therefore, actively exploring the effective path of integrating the park

city concept with urban planning and improving the corresponding technical methods are still the keys to promote the scientific construction of park cities as shown in Figure 1.

2. Review of the Domestic and Foreign Literature

The review of the existing research starts from two aspects: firstly, the summary of smart cities, and secondly, the summary of the existing research on the concept of "park city," which is the perspective of this research.

2.1. Discussion of the Concept of Smart City in Domestic and International Research. As a typical representative of the smart city program proposed by IBM, many scholars pay more attention to the technical connotation of the smart city. IBM, the first company to propose a smart city construction program, states that a smart city is a city that uses information technology to transform its core systems and optimize the use of limited resources. That is, by creating a connected, interoperable, and intelligent urban system, policy makers and citizens can gain insight into urban activities and their new trends from large amounts of data to make more informed decisions [7]. Similarly, Colin Harrison and Ian Abbott Donnelly (2011) argue that a smart city is a city that makes full use of urban information systems to plan, design, invest, build, manage, and operate urban infrastructure and services. Similarly, many scholars in China also pay more attention to the technical connotation of smart cities. For example, Wang Jiayao et al. (2011) believe that a smart city is to make the city smarter; it is through the Internet to connect the ubiquitous intelligent sensors implanted in the city to form the Internet of Things, to achieve a comprehensive perception of the physical city, and then use cloud computing technology for intelligent processing and analysis of the

perceived information, to achieve the integration of the online “digital city” and the Internet of Things, and issue instructions for government, people’s livelihood, environment, public safety, public services, and the then, cloud computing technology can be used to intelligently process and analyze the sensory information to achieve the integration of online “digital city” and IoT, and issue commands to make intelligent responses and intelligent decision support for various demands including government, people’s livelihood, environment, public safety, public services, and business activities [8]. According to Lee, a smart city is an intelligent city management and operation that is visualized and measurable on the basis of comprehensive digitalization of the city, which is more concisely stated as “smart city = digital city + Internet of Things”. Many scholars believe that information technology is only the foundation of a smart city, and only when information technology is well integrated and integrated with the main development areas of the city, such as economy, society, and ecology, can such a city become a smart city [9]. According to Georgios et al., smart cities are all urban solutions that pursue multiple economic and social goals such as prosperity, efficiency, and competitiveness through purposeful and strategic investments in emerging information and communication technologies [10]. After analyzing many cases of self-labeled smart cities in North America, Europe, and Southeast Asia, Holland (2008) found that the main factors involved in these smart cities are information technology and networks, education and learning, entrepreneurial and innovative environments, and economic development, public services and governance paradigm shift, social capital and social integration, environment and sustainable development, and he pointed out that the development of smart cities should start from focusing on the reality of people in the city (such as needs, knowledge, skills) and the corresponding status of human capital, based on which a balance should be struck between the application of information technology in business, government, community, and other areas and the general citizens of the city, as well as between economic development and sustainable development [11]. The concept of a smart city has been extensively analyzed by scholars at home and abroad from different perspectives, but the specific kind of city is a smart city. There are several distinct categories of views, and the views of different scholars in different categories are not the same. The definition of the concept of a smart city is the starting point of smart city research; at the same time, different definitions of the concept of a smart city have an important role in guiding the practice of smart city construction, such as the definition of the technical level is likely to make the construction of smart city into the misunderstanding of technology-only theory. Nevertheless, different scholars’ definitions of the concept of a smart city reflect the theoretical definition of the new thing called smart city based on different perspectives, and the relevant views lay the foundation for an in-depth analysis of the new thing called a smart city in this paper.

Secondly, in February 2018, General Secretary Xi Jinping pointed out during his inspection of Tianfu New Area in Sichuan that “Tianfu New Area is an important node in the construction of “One Belt and One Road” and the development of Yangtze River Economic Belt, and must be well planned and constructed, especially to highlight the characteristics of park cities, take ecological values into account, strive to build a new growth pole, and build an inland open economic highland. On April 2 of the same year, General Secretary Xi Jinping once again emphasized that the greening of the motherland should adhere to the people-centered development ideology when he attended the compulsory tree-planting activities in the capital. In recent years, before and after the park city concept was proposed, many cities such as Guiyang, Yangzhou, Chengdu, and Qingdao have also promoted urban planning and construction around the park city concept [12]. Wang and other cities have promoted the planning and construction of park cities through the enactment of park system planning and park regulations before the park city concept was proposed. In April 2016, Guiyang proposed to build an urban park system with a “balanced layout, reasonable structure, perfect function, beautiful environment, close to life, and service to the public” and promoted the action plan for the construction of the “City of a Thousand Gardens” according to the basic principle of “municipal coordination, district and county-oriented.” In September 2017, Yangzhou proposed to promote the construction of park cities and improve the level of park management, and adopted the “Yangzhou City Park Regulations” at the fourth meeting of the Standing Committee of the Eighth National People’s Congress, which has a profound impact on its urban development and livelihood construction. In Chengdu and other cities, after the park city concept was proposed, the three plenary sessions of the 13th Municipal Committee made a decision to accelerate the construction of beautiful and livable park cities and started the planning and construction of park cities.

The “park city” concept is a new goal and a new stage of urban development and a new process of China’s habitat development, which is adapted to the new era of China’s urban ecology and habitat development situation and demand, and to ensure the sustainable development of urban construction. Since its introduction in February 2018, “park city” has aroused widespread attention and discussion, and different scholars have carried out research in terms of historical combing, connotation characteristics, guiding ideology, principles, and planning and construction practices. By sorting out the historical evolution of “park-city” in relation to the development of habitat civilization, it was clarified that park city is an inevitable stage of historical development in the current new era. Michele et al. proposed five typical characteristics of the “park city” concept: “people-oriented, ecological foundation, urban-rural coexistence, beauty-led, and multiple coexistence” and the corresponding practical paths [13]. Michele et al. analyzed the development concept and connotation characteristics of the park city by reviewing the classical ideas of park-making in ancient and modern times in China, proposed the

development strategy of “three major, three plastic and three senses” and used the planning method of “four new and one soul” to build a hierarchical construction system of the urban park from four levels: ecological base, spatial construction, infrastructure, and human living environment [14]. Richard et al. explored the positioning of the “park city” concept in terms of spatial integrity, park system, and stage development through a review of its origin and historical development process, and proposed that the park city should meet people’s aspirations for a better and happier life under the guidance of people and national demand and resource integration and that the park should lead the development of the city and the “three lives”. On the basis of this, the characteristics of the park city are proposed to meet people’s aspirations for a better and happier life, park-led urban development, and the integrated development of “three lives” under the guidance of people and national needs and resource integration [15]. Wang et al. explored the landscape gardening practice strategy under the goal of building a beautiful and livable park city in Chengdu and proposed corresponding practice strategies in five aspects: urban ecological pattern, urban morphological pattern, the whole area park system, beautiful and livable environment and livable life [16]. Through understanding the connotation of “park city”, Valente et al. proposed the guiding ideology and basic principles of park city construction and “constructing ecological network system, expanding and improving green space system, establishing and improving park system, constructing urban green shade network, carrying out “urban double repair”, promote cultural inheritance, enhance the comprehensive functions of parks, and innovate park management mode” [17]. Maru and Worku discussed the theoretical value and significance of the “park city” in contemporary China through the analysis of the history of urban civilization and several cases of urban areas [18]. Miroslava and Katarína summarized the history and scientific experience of the development of habitat environment and analyzed the origin of the park city concept from it. At the same time, he explored the concept of life, space time, analysis, and synthesis of the park city with the help of the epistemology of habitat environment, and on this basis, he discussed the goal and value system of building a park city and proposed the realization path of the trinity of “people, city, environment and industry” and the development model of ECD park city center [19]. On the basis of the value and significance of park city construction, Wu and Guo analyzed the purpose and connotation of the development concept of “unity and coordination of environment and people’s livelihood, high integration of landscape and ecology, harmonious coexistence of city and nature, and integration of internationalization and regionalization” and proposed the construction contents and paths of “optimizing urban space, protecting ecological resources, improving human living environment and guiding green life” [20]. The study also proposed the construction contents and paths of “optimizing urban space, protecting ecological resources, improving living environment and guiding green life” [20].

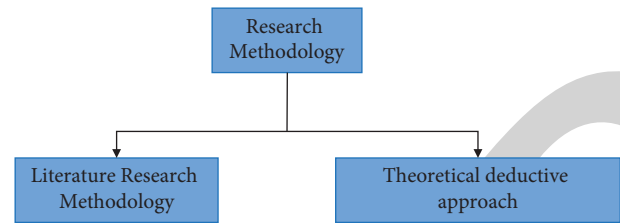


FIGURE 2: Research methodology.

3. Research Content and Methodology

3.1. Research Content. In this study, we firstly propose the important research question of “what is a park city” and analyze the significance of this question from the current situation of the emergence and construction of park cities. Secondly, the study will absorb the experience of other regions in building park cities. Finally, the study will combine the intelligent detection sensors with the construction of Qingdao park city and summarize the theoretical research of this study.

3.2. Research Methods

3.2.1. Literature Research. In order to explore the theoretical connotation of the park city system systematically and deeply, this study has extensively reviewed and analyzed the literature and data of park city research at home and abroad, and has comprehensively summarized and concluded the connotation of the concept of park city in related research at home and abroad, which has laid the foundation for analyzing the connotation of park city and park city system in this study.

3.2.2. Theoretical Deduction Method. This study combines the definition of a system, the metaphorical view of system, the hierarchy and emergence of system, the communication and control of the system and other related theories in the theory of system, as well as the elements and characteristics of the urban system in the theory of urban system, and carries out a standardized theoretical analysis of the concept, elements, and structure of smart city system, and constructs a model of the smart city system, forming some basic ideas about smart city system in this study. Some basic ideas about the smart city system are shown in Figure 2.

4. Results and Discussion

4.1. Results. This study uses the Natural Breaks classification method to classify the area scale of urban ecological parks. The Natural Breaks classification method is based on the natural grouping inherent in the data to identify the classification interval, so as to group the similar values most appropriately and maximize the differences between the categories. Natural Breaks is a statistical classification method based on the natural characteristics and laws of data

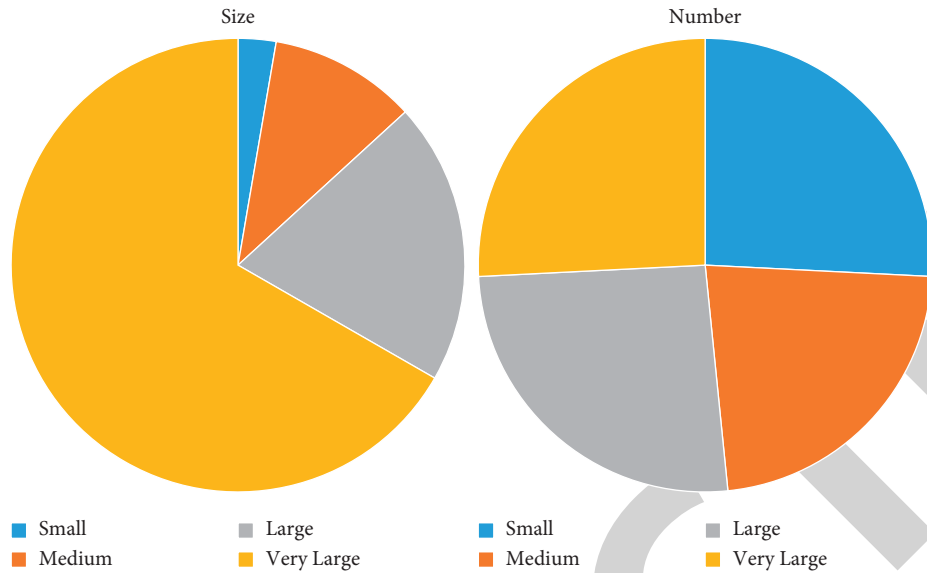


FIGURE 3: Analysis of the area and number of urban ecological parks.

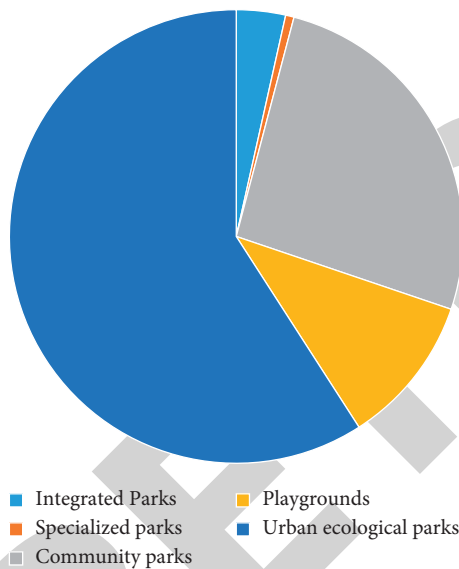


FIGURE 4: Per capita park green space statistics for various types of parks.

distribution, which is more scientific and reasonable than the subjective classification method, so this study adopts this classification method and uses the analysis results in ArcGIS software to classify the area scale of urban ecological parks into four categories: small 1–10 hm², medium 10–35 hm², large 35–60 hm², and small 1–10 hm²; 35 hm², large 35–60 hm², and extra-large 60–255 hm². Among them, there were 7 medium-sized urban ecological parks with a total area of 178.37 hm², 8 small-sized, large-sized, and mega-sized, with a total area of 45.6 hm², 339.87 hm², and 1131.61 hm² respectively and, thus, it can be seen that the number of various types of urban ecological parks is relatively even, but the area percentage varies greatly, and mega-sized urban ecological parks with an area of more than 60 hm² account

for the most, 66.7%, while small-sized ones account for the least, only 2.7% as shown in Figure 3. The largest urban ecological park with an area of more than 60 hm² is 66.7%, while the smallest one is 2.7% as shown in Figure 3.

It is planned that by 2022, the green area of the Northern New Area will reach 5330.62 hm², the green area rate will be 46.29%, the green coverage rate will be 51.29%, and the per capita park green area will be 20.58 m²/person. Among them, the area of park green space is 672.97 hm², the area of EG regional green space is 2228.26 hm², and 973.03 hm² of regional green space is included in the park green space index for statistics. The green space included in the calculation of park green space per capita in the regional green space accounts for 59.1% of the overall green space, accounting for the largest proportion and the largest area. Among the park green areas, the proportion of comprehensive parks is about 3.5%, the proportion of special parks is about 0.6%, the proportion of community parks is about 26.1%, and the proportion of pleasure gardens is about 10.7% as shown in Figure 4.

Ecological parks have better natural resources and are more attractive than ordinary urban parks in meeting people’s desire for nature and, therefore, have a wide range of users. Based on the analysis of field research results, the following statistics are provided on the age and group composition of urban ecological park users.

4.1.1. Age Composition. The age of the survey respondents was divided into four stages: under 18, 18–40, 41–60, and over 60 years old. The survey results show that the age distribution of park users is relatively wide, with minors accounting for 5.3% of the total number of users, young people aged 18–40 accounting for 17.1%, middle-aged people aged 40–60 accounting for 50.7%, and elderly people aged 60 or older accounting for 26.9% as shown in Figure 5.

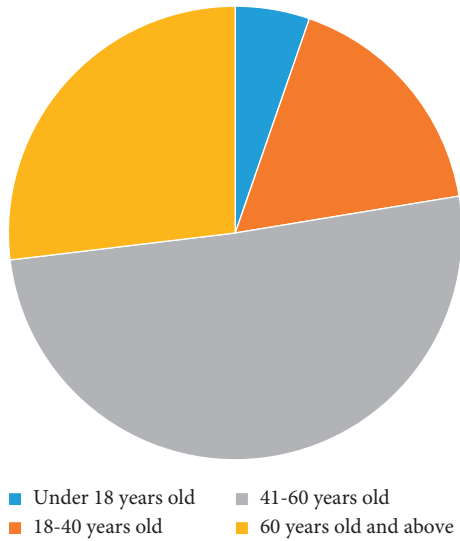


FIGURE 5: Analysis of age composition of users.

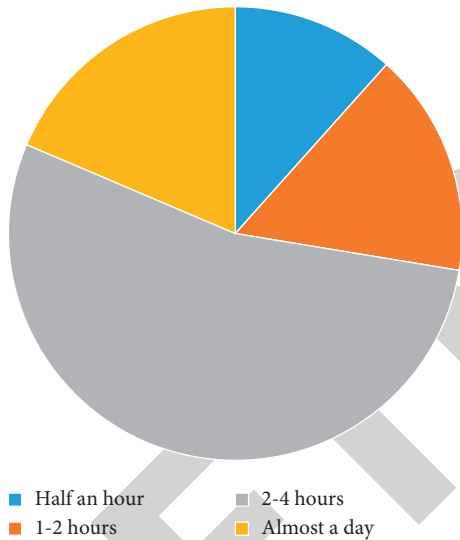


FIGURE 6: Length of stay of users.

4.1.2. *Length of Stay.* The length of stay in the park was divided into 4 levels: about half an hour, 1–2 hours, 2–4 hours, and almost a day, as shown in Figure 6.

4.1.3. *Use Function.* The analysis of the use function of urban ecological parks can provide a quick and effective understanding of the characteristics of the arrangement of park functions and activities. Therefore, this study conducted a statistical analysis of the functional layout of Chongqing’s urban ecological parks based on field research and data studies. From the analysis results, the functional layout of urban ecological parks in Chongqing is divided into seven types, which are ornamental tours, leisure activities, quiet rest, children’s games, elderly activities, sports and fitness, and science demonstration, among which leisure activities and quiet rest account for the most of all parks, followed by an ornamental tour and sports and fitness, and

children’s games, elderly activities, and sports and fitness are set in some parks as shown in Figure 7.

Under the guidance of the “park city” concept, the city will become a green ecological system, and urban parks, as an important part of the system, play a leading role in the planning and construction of the “park city” concept. In Qingdao’s urban planning, a large number of urban ecological parks, unique land conditions, and rich landscape resources make it an important grip for the construction of a good living environment and an important support system for the construction of a “park city”. The planning and design of urban ecological parks under the concept of “park city” needs to play the basic role of environmental and ecological protection, the main role of green functional space, the leading role of park features, and the need to meet people’s demand for suitable human living activities as shown in Figures 8 and 9. Therefore, based on the current problems of urban ecological parks, the concept of “park city” is used to solve many problems of urban ecological parks from macroscopic site selection and layout to microscopic use level.

4.2. *Discussion.* At the macro level, the site selection and layout of urban ecological parks should protect the continuity and integrity of the original natural landscape and green space of the city, take the planning of urban ecological parks combined with the green space system as a prerequisite element of urban planning, give full play to the land reservation capacity of parks, and prevent the destructive construction of interrupted mountains and water in the process of urban development. At the same time, on the basis of protecting and restoring the natural texture, the city and the park should be integrated and nested to form an urban pattern that reveals the mountains and water, and the blue and green, so as to facilitate the maintenance of the ecological environment inside the city and the introduction of natural patches at the edge of the city, and thus improve and strengthen the green ecological space system in the city. At the meso-level, since urban ecological parks are characterized by a large number, large scale, and rich landscape resources, it is necessary to fully consider the scale level and type characteristics and clarify the scale level and type positioning of urban ecological parks, so that urban ecological parks can have more scale coordination and functional relevance under the influence of the “park city” concept. The scale and type of urban ecological parks should be clearly defined, so that they can be more coordinated in scale and function under the influence of the “park city” concept. At the same time, it is necessary to pay attention to connectivity and form a complete park system with other parks in the city. At the micro level, the existing problems of the urban ecological parks are combined with the traffic, space, functions, activities, and supporting facilities to propose corresponding design optimization strategies, in order to create a convenient, comfortable, green, energetic, and applicable urban ecological parks, to create a good feeling of park use, and to create a livable and green life for urban residents.

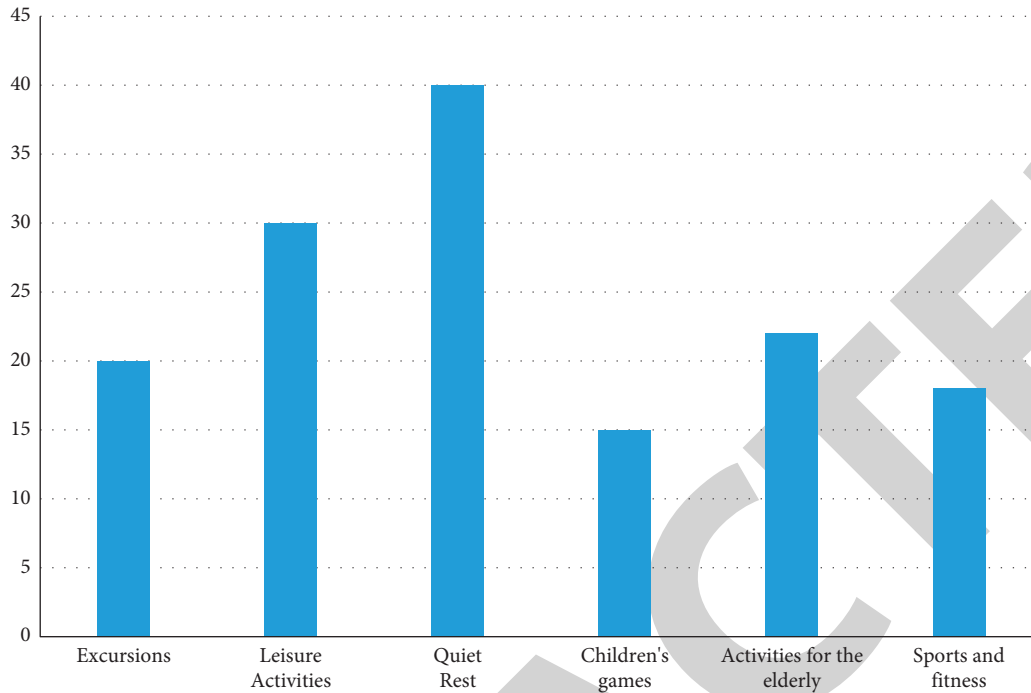


FIGURE 7: Park use function.

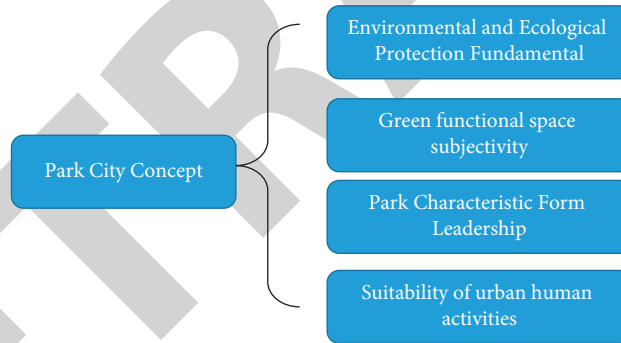


FIGURE 8: "Park City" concept.

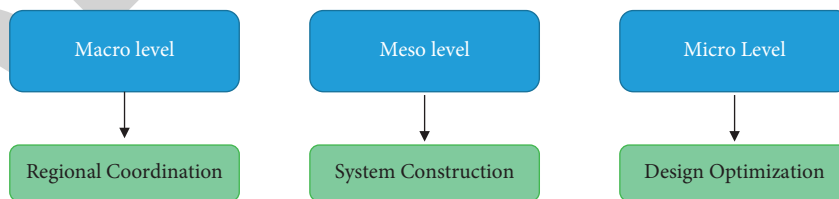


FIGURE 9: Different planning levels of "Park City."

At the meso-level, since urban ecological parks are characterized by a large number, large scale, and rich landscape resources, it is necessary to fully consider the scale level and type characteristics and clarify the scale level and type positioning of urban ecological parks so that they can be more coordinated in scale and relevant in function under the influence of the "park city" concept. The scale and type of

urban ecological parks should be clearly defined, so that they can be more coordinated in scale and function under the influence of the "park city" concept. At the same time, it is necessary to pay attention to connectivity and form a complete park system with other parks in the city.

At the micro level, the existing problems of the urban ecological parks are combined with the traffic, space,

functions, activities, and supporting facilities to propose corresponding design optimization strategies, in order to create a convenient, comfortable, green, energetic, and applicable urban ecological parks, to create a good feeling of park use, and to create a livable and green life for urban residents.

4.2.1. The Urban Ecological Park Site Selection and Layout Optimization. First of all, we need to use scientific methods and technologies to determine the suitable green areas for urban ecological parks. In the specific operation, we can use index evaluation, demand research, and other methods to evaluate the ecological services and social services of green areas through mature evaluation and analysis methods such as ecological sensitivity analysis and ecological service trade-offs. In terms of ecological services, the three-dimensional green volume, biodiversity, impact on hydrological processes, and microclimate of green areas are evaluated; in terms of social services, the location conditions, accessibility, and demand for surrounding uses of green areas are evaluated. By integrating the results of ecological and social services assessment and grading the green areas, we can, on the one hand, more scientifically determine the green areas suitable for development as urban ecological parks and, on the other hand, more reasonably guide the direction of urban ecological park construction and development. As we can see from the previous analysis, the scale of urban ecological parks ranges from a few hectares to hundreds of hectares, and the construction of a multi-level balanced urban ecological park system is conducive to giving full play to the ecological benefits and equalizing the social services of parks in the construction of park cities. The ecological attributes of urban ecological parks are different from those of general urban parks in the construction of park cities, and related research shows that the ecological attributes of urban ecological parks are directly related to their area size when other conditions are the same. When the area of an urban ecological park reaches a segmented value, the increase in ecological benefits brought by the increase in area is extremely slow, but the increase in the service scope and attractiveness of the park requires more activity space to match it. Therefore, based on theoretical and practical experience and the morphological and functional characteristics of urban ecological parks, this study classifies urban ecological parks into four levels: regional, urban, community, and belt type.

According to the park city concept and the previous analysis, we can conclude that urban ecological parks not only have the functions of ordinary urban parks, but also their functional characteristics are focused on the protection of natural landscape resources, overall ecological maintenance, diversified activity development, and introduction of ecological technology. In the planning and design of urban ecological parks, we can classify urban ecological parks according to different landscape resource conditions, and regional characteristics and locate different leading functions on the basis of the overall functional complexity of urban ecological parks, which can help guide the

construction of urban parks scientifically and realize the reasonable configuration of urban parks.

(1) Nature Conservation Type. Nature conservation type urban ecological park is an urban ecological park with a good natural ecological environment or important ecological significance, and its function is realized mainly by protecting and using the original resources. In order to avoid ecological damage caused by construction activities in the city, important natural resources, and ecological areas are protected through the planning and construction of the park, and on this basis, various activities such as scenery viewing, hiking, and trekking, which are suitable for the environment, are developed, balancing the relationship between protection and utilization, with the main orientation is to protect the environment and resources, to maintain the originality of the ecological environment, to ensure the ability of the park to maintain itself in the system as much as possible, to bring into play the functional characteristics of the park, and to ensure the green base of the park city construction.

(2) Development-Led Type. Development-led urban ecological parks are built on the basis of the urban skeleton of important mountains and primary and secondary river systems within the city and at the edges of the city, and their planning and construction are based on preserving and protecting the urban landscape pattern, protecting the urban landscape skeleton, maintaining its ecological function in the overall system, controlling the spread and encroachment of urban land, and linking with other urban green space to form an ecological The ecological park is formed with ecological conservation and resource protection as its core. This type of park planning and construction is based on the determination of the scope of protection and the development of activities with a low degree of interference, in order to promote the formation of a good environmental foundation of the city while guiding the rational development of the urban spatial structure.

(3) Environmental Restoration Type. Environmental restoration type urban ecological park is an urban ecological park whose original base is deserted but is in an important urban ecological process or the natural ecological environment has been damaged by pollution, and its function is realized mainly by restoring the damaged environment and ecosystem through ecological technology. In the planning and construction of this type of urban ecological park, ecological technology is mainly introduced to restore and repair the environment in the area with a purpose and direction to enhance the ecological nature of the park, and on this basis, the park's science education activities are developed through the introduction of relevant technology, experience and demonstration of the restoration process to realize the composite function of the park.

(4) Landscape Recreation Type. The landscape recreation type urban ecological park is established on the basis of some of the remaining green areas in the city or the periphery of the core ecological buffer zone which is closely connected

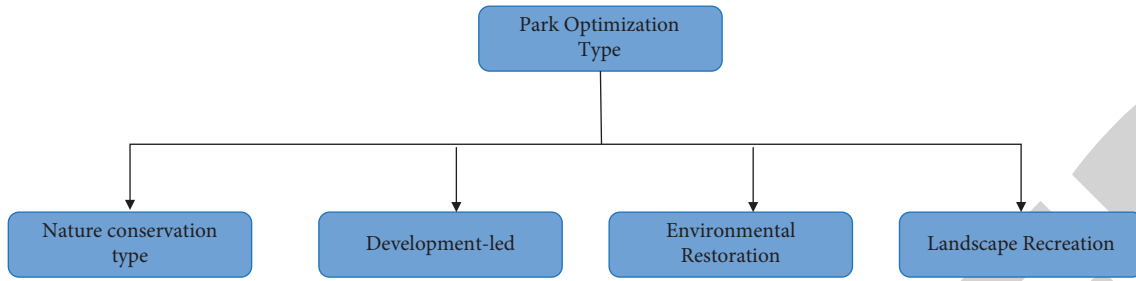


FIGURE 10: Optimization of urban ecological parks in terms of site selection and layout.

with the city, and after a certain degree of artificial transformation, the landscape of the park activity space is upgraded and improved to meet the diverse nature experience and outdoor interaction needs of urban residents. Landscape recreation type urban ecological park is the most developed and utilized type, and its functions are more comprehensive. In the planning and construction, it is necessary to pay attention to reasonable restrictions on the intensity, mode, and content of development and utilization, and to balance the contradiction between protection and utilization in a scientific and orderly manner as shown in Figure 10.

4.2.2. Urban Ecological Park Design Strategy Improvement.

On the one hand, since most urban ecological parks are built on the basis of mountainous water systems in cities, there is a significant height difference between the park and the urban interface, so it is an important way to improve the accessibility of the park by enriching the multi-dimensional traffic structure and overcoming the height difference between inside and outside. On the other hand, the boundary space of urban ecological parks has the functions of behavior guidance, connection and transition, landscape display, etc. Therefore, strengthening the permeability between the boundary space of parks and urban space is also conducive to improving people's perception of parks and attracting them to parks.

(1) *Traffic Management.* On the one hand, we pay attention to the connection between the internal and external transportation systems of urban ecological parks. The park entrances and exits should be close to existing roads, highways, and bus stops to improve the convenience of entering the park; at the same time, additional hiking entrances should be set up near the urban greenways to interconnect the park with the urban slow walking system, improve the walkability of the park, and increase the service efficiency of the park. On the other hand, we pay attention to the optimization of the internal transportation system of the park. The height difference between the park interface and the urban interface will be fully considered, and a multi-dimensional traffic system will be formed through the horizontal and vertical traffic combing to realize the height difference into zero. In terms of horizontal traffic, the park road is designed parallel to the city road and the boundary space to guide people into the park in a hierarchical way, and at the same time to ensure a good connection between up and down traffic.

In vertical traffic, vertical traffic such as steps and ramps and barrier-free traffic facilities such as elevators and escalators are used to solve the problem of height difference, and full attention is paid to the design of railings, handrails, and resting platforms, and the platforms are extended and resting facilities such as seats are set in places where conditions are available. In order to meet the safety problems and practical needs of urban residents, we also provide a good leisure place for community residents.

(2) *Border Penetration.* On the one hand, to increase the permeability of the boundary space of urban ecological parks, soft and permeable walls are used instead of hard walls in places where boundaries are needed to blur the boundaries between the inside and outside of the parks, to enhance the visual openness of the parks, and to a certain extent, to dispel the psychological implication that the boundary space is inaccessible, so as to attract people to enter the parks more often. On the other hand, in places where there is a natural height difference, it is necessary to strengthen the guidance and identifiability of the border space, using the form of greening of the fortress and greening of the platform to form a good border landscape experience, while strengthening the continuity of the border space by means of continuous greening and signs to guide people into the park.

4.2.3. Rational Development of Landscape Resources to Enhance the Comfort of Visiting.

On the one hand, the construction and functional arrangement of the park should be integrated with the original environment to protect the original natural habitat conditions; on the other hand, according to the differences of different landscape resources in terms of spatial form and sensory characteristics, the appropriate functional areas should be reasonably arranged to achieve the harmonization of the park functional areas and natural habitat. On the other hand, according to the differences in different landscape resources in terms of spatial forms and sensory characteristics, we can reasonably arrange suitable functional areas to achieve the harmonization of park functional areas and natural habitats.

(1) *Rational Use of Space in Different Terrain Types.* The complex and changing topography of the city constitutes the unique topographic space of the urban ecological park, and the differences in the characteristics of different topographic

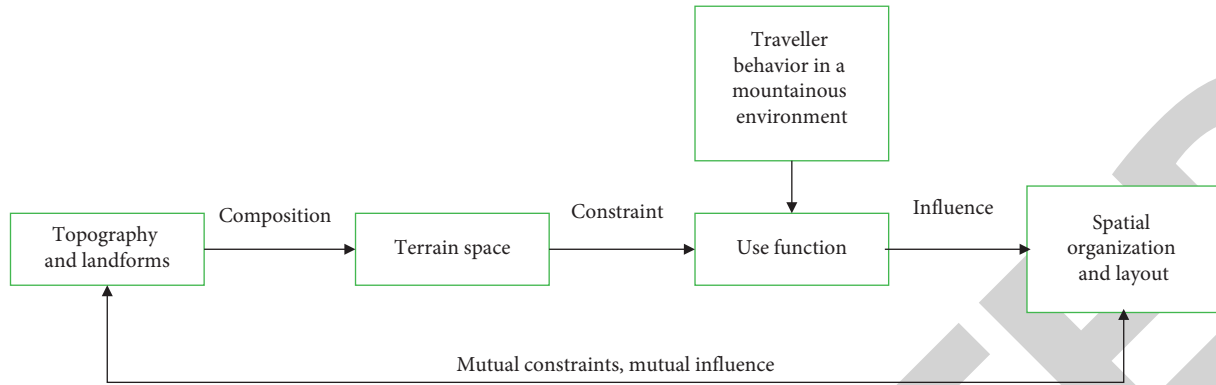


FIGURE 11: Relationship between topographic layout and spatial organization.

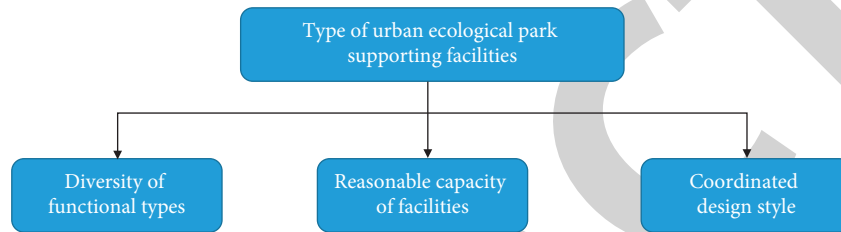


FIGURE 12: Types of urban ecological park facilities.

spaces restrict their different functions. At the same time, the behavior of visitors’ recreational activities also affects the distribution of different functional spaces of the park under various topographic conditions. Therefore, different topographic conditions and the organization of various spaces in the park are mutually influenced and constrained by each other as shown in Figure 11.

Combined with the previous analysis, it can be seen that urban ecological parks can realize people’s needs for close proximity to nature and ecological experience in the city. Therefore, in the planning and design of urban ecological parks, it is important to provide more types of activities and spaces that meet people’s needs, so as to highlight the characteristics of urban ecological parks. The characteristics of urban ecological parks also strengthen the park’s recreation service capacity.

4.2.4. Urban Ecological Parks and Their Supporting Facilities.

The type, quantity, and design style of the supporting facilities of urban ecological parks are closely related to the leading functions of the parks, the behavioral activities of users, and the style characteristics of the parks, which are important carriers to support and improve the functions of the parks, and the configuration of the facilities also has a great impact on the protection and utilization of the park environment. On the one hand, a complete set of functional facilities is the guarantee for the realization and full utilization of the functions of urban ecological parks; on the other hand, a reasonable and scientific allocation and arrangement of facilities can effectively balance the contradiction between the protection and utilization of resources in urban ecological parks, effectively protect and maintain the park environment,

and also promote the reasonable and effective utilization of resources in parks. The characteristics of the urban ecological park are shown in Figure 12.

(1) *Various Types of Functions.* The various types of supporting facilities in the urban ecological park are an important manifestation of its perfect functions, such as activity facilities and rest facilities, which can meet the different needs of visitors and improve the park’s recreation and basic service capacity; sanitation facilities, which can effectively protect the environmental health of the park and implement effective protection while reasonably organizing and guiding the use of natural resources in the park; a perfect signage system can guide visitors to tour in an orderly and a perfect signage system can guide visitors to visit the park in an orderly and purposeful manner, and also present the environmental characteristics and resource features of the park clearly, which enhances the recognizability of each park recreation space. Therefore, in the specific design of urban ecological parks, we should try to diversify the functional types of supporting facilities and choose the corresponding supporting facilities in each recreation space by combining the site resource conditions and visitors’ activity preferences, so as to realize the perfect function of the park and the effective use of recreation space.

(2) *Reasonable Capacity of Facilities.* Due to the special land type of urban ecological park, there is no land index for the supporting facilities in the park, so the arrangement of their quantity and volume is greatly restricted. Therefore, in the specific design, on the one hand, we should try to convert the single large volume supporting facilities into scattered small volume supporting facilities, and the fixed supporting

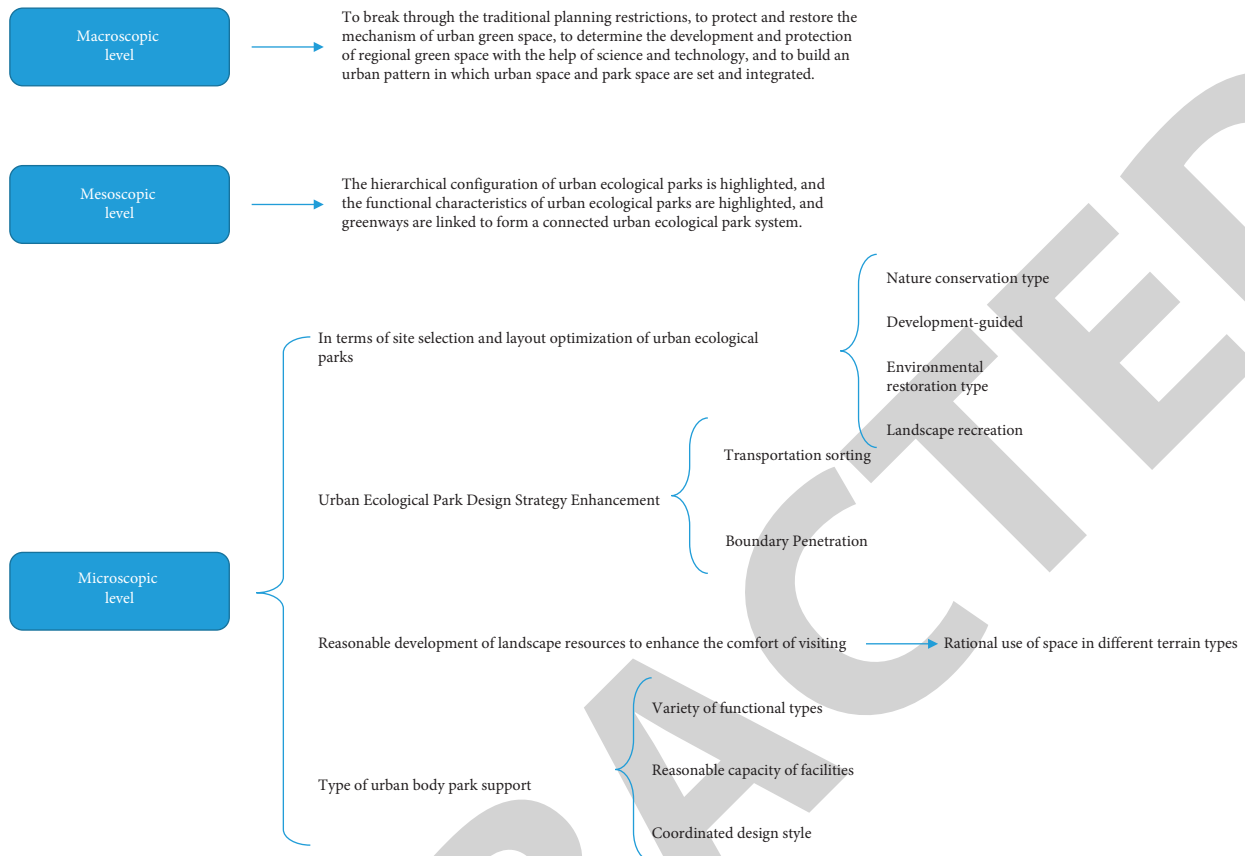


FIGURE 13: Different levels of "park city" construction.

facilities into movable temporary supporting facilities, and at the same time, link the infrastructure service facilities around the city to form a perfect infrastructure service facility system inside and outside, so as to guarantee the perfect park facilities and solve the dilemma of limited land for supporting facilities in the park at the same time. On the other hand, in the case of limited land for supporting facilities in urban ecological parks, the arrangement should follow the principles of resource conservation and centralized utilization, increasing the configuration of facilities in areas with frequent and intensive activities, and reasonably dividing the site into small spaces in areas with less visitor activities, and appropriately reducing the configuration of facilities. At the same time, temporary movable facilities are used to alleviate the instantaneous pressure of facility use in the park during the holiday season when there are a large number of people. By controlling the number and volume of facilities and arranging them in a reasonable manner, the efficiency of the utilization of the facilities can be improved.

(3) *Coordinated Design Style.* The natural and wild style of the urban ecological park is the characteristic that distinguishes it from other parks, so the design style of the supporting facilities should be coordinated with the style of the park. On the one hand, the arrangement of the facilities should be integrated with the atmosphere of the site space to reduce the interference with ecologically sensitive areas and avoid conflicts with the original natural environment of the

park or damage to its ecological functions. On the other hand, the form and material of the facilities should be coordinated with the style of the site, and natural elements should be used as much as possible, such as native green materials, recyclable and biodegradable ecological materials, to ensure the functionality of the facilities while reflecting the green, ecological and wild park style as shown in Figure 13.

5. Conclusion

The rapid development and widespread application of new generation information and communication technologies have triggered changes in urban development patterns, and smart cities have become a new urban development concept that has come into view in recent years and has triggered a boom in the exploration and practice of smart cities around the world. This study takes Qingdao city as the research object and finds out the problems in the planning and construction of such parks through relevant data and extensive research. This study analyzes the planning and construction of ecological parks in Qingdao based on the theoretical guidance of the "park city" concept and case studies at different levels and proposes appropriate planning and design strategies for the construction of park city in Qingdao from a macroscopic site selection and layout, mesoscopic system construction and microscopic use.

Retraction

Retracted: Analysis of Legal Issues of the Crime of Endangering Public Safety Based on Data Mining Algorithm

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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] Y. Xu and T. Feng, "Analysis of Legal Issues of the Crime of Endangering Public Safety Based on Data Mining Algorithm," *Security and Communication Networks*, vol. 2022, Article ID 4794752, 12 pages, 2022.

Research Article

Analysis of Legal Issues of the Crime of Endangering Public Safety Based on Data Mining Algorithm

Yaqiong Xu¹ and Tao Feng ²

¹Shaanxi Police College, Xi'an, Shaanxi 710021, China

²Beihang University, Beijing 100191, China

Correspondence should be addressed to Tao Feng; feng_tao@buaa.edu.cn

Received 5 July 2022; Revised 9 August 2022; Accepted 18 August 2022; Published 21 September 2022

Academic Editor: Tao Cui

Copyright © 2022 Yaqiong Xu and Tao Feng. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

In order to improve the analysis effect of legal issues of the crime of endangering public safety, this paper analyzes the legal issues of the crime of endangering public safety based on the actual mining algorithm and uses numerical methods to qualitatively study the evolution behavior across phase intervals. Moreover, this paper improves the algorithm based on the actual needs of legal mining. When solving the eigenvalues of the given Hamiltonian's duration equation, the zero-energy solution can be found in the case of open boundaries. In addition, this paper applies the improved algorithm proposed in this paper to the mining of criminal law legal issues of crimes against public safety, assigns a dynamic IP to each process, and builds a model based on this. Through the above simulation research, it can be seen that the legal problem analysis model of the crime of endangering public safety based on the data mining algorithm proposed in this paper has a good legal data mining effect.

1. Introduction

The application of data mining to the criminal law mining of crimes endangering public security can not only effectively improve the effective definition of legal knowledge, but also play an important role in the qualitative analysis of public security crimes, which is of great significance to the subsequent popularization of legal knowledge and the norms of public behavior.

The development and changes of the industrial revolution and technological transformation have greatly improved the level of productivity, transformed human life concepts and lifestyles to a certain extent, and also improved living standards and quality of life. While creating productivity unmatched by traditional society, it also creates many new sources of danger, bringing unprecedented material convenience to human beings, and making the spread of technological risks increasingly serious [1]. With the advancement of technology and the improvement of living standards, the dangers people face in life are also strange. The dangers contained in the own system of

industrial society have involuntarily mutated into a risk society. At different stages of human social development, the emphasis and inclination of legal protection are also different. In contemporary times, the society is full of various dangers, and the safety of public life and property is increasingly valued and protected, so the application of data mining technology to the law is of great significance [2]. Especially in the context of today's risk society, harmful behaviors against the public are increasing, and necessary measures should be taken in a timely manner for some behaviors that pose a major threat to public security interests and have serious social harm. Although serious consequences have not yet been caused, it is necessary to eliminate in the bud to protect public interests. Especially with the proliferation of cyber crimes, it is difficult for traditional legal supervision to deal with cyber crimes, especially for the qualitative treatment of cyber security crimes [3]. The specific definition of "dangerous" is not specified in the criminal laws of various countries. In the context of crime composition, the word "danger" not only assumes the function of fact-finding, but also bears the function of value

judgment, which means the possibility of suffering damage or failure [4]. Therefore, it does not mean that causing a specific dangerous state is a “danger” regulated by the criminal law. The dangerous state itself must also meet the needs of value judgment; that is, the harmful behavior must also cause the danger of infringing on specific legal interests. Taking the legal explosion as an example, although it also causes danger, it is not a danger of harming public safety, so we can deny the existence of this “danger” from the perspective of value. Similarly, when judging whether a certain danger meets the requirements of dangerous criminals, it is necessary to judge from the dual functions of fact and value, and one-sided emphasis on one is biased behavior [5].

Safety has become a common concern and a more sensitive topic in the whole society. From the field of transportation to the field of medicine and health, the field of environment and the field of food safety and then to the field of production and operation, dangerous events emerge in an endless stream in society. As the last line of defense in social control, criminal law sets up crimes against public safety in dealing with dangers and is committed to combating criminal acts that threaten or harm public safety, so as to protect the legal interests of public safety. However, with the social changes, illegal and criminal behaviors are also full of tricks. Stealing manhole covers, driving to touch porcelain, racing cars, producing and selling toxic and harmful food and raw materials, and drunk driving and other dangerous behaviors collide with our fragile sense of security and panic. At the same time, the current situation of judicial organs dealing with dangerous crimes and convicting crimes against public security has also caused certain social anxiety, which not only makes people feel the special effect of criminal law sanctions on dangerous acts, but also causes people to worry about the abuse of judicial power [6]. In the face of these new behaviors that were not predicted at the time of legislation, the crime of endangering public safety by dangerous methods has become an important means for judicial organs to govern risky society. Is it based on reasonable interpretation and application of criminal law? Do some radiation radii violate the principles of criminal law? How can we ensure that the crime of endangering public safety by dangerous methods always adheres to the bottom line of the principle of legality of crime and punishment? How to ensure the instrumental nature of the criminal law in an authoritarian society, to play the normative role of the criminal law in the response to social crises, to achieve the purpose of the criminal law, and to ensure the freedom and tranquility of citizens without interference to the greatest extent cannot help but lead people to think about it; in the face of various behaviors, how to define criminal behavior requires some support from data mining technology [7].

Literature [8] pointed out that public legal interests include social legal interests and national legal interests, while social legal interests are the abstraction or generalization of individual legal interests and form a separate field within this scope. For public security crimes in social legal interests, the legal interests to be protected are the safety of

the life, body, and property of the public, and public danger is defined as the possibility of infringing the lives, bodies, and property of unspecified or most people. The qualitative analysis of the crime of public security provides a theoretical basis. Literature [9] pointed out that the general public danger crime is a crime that violates the life, body, or important property of unspecified or most people, and it is aimed at this social legal interest called compound personal interest, rather than abstract social interest. And social system is also a kind of qualitative analysis behavior, in line with the algorithm conditions of data mining. Reference [10] believes that “unspecific or majority people” can achieve the goal of combating public safety crimes, and the core lies in the majority of objects. The understanding of unspecific refers to the unspecific nature of the criminal object, as well as the unspecified results of specific harm. For a specific crime object, it has caused unspecified harmful results beyond the scope of the specific crime object. Although the actual result is beyond the original intention of the perpetrator, it actually endangers public safety. For the understanding of public danger, we should not only take into account the purely objective and physical dangers, but also pay attention to the psychological factors, that is, to identify the public danger concept by capturing the insecurity of ordinary people, which requires data mining algorithms to carry out behavior classification processing [11]. Regarding the understanding of data mining for dangerous data processing, the literature [12] pointed out that there are two different understandings: one is the behavioral risk theory that the behavior produces the danger of infringing the protected interests, and the other is that the actor is antagonistic, that is, the theory of danger of dangerous actors in society. With the development of the objectivist criminal law theory, the behavioral risk theory gradually replaces the perpetrator’s risk theory. There is a debate about behavioral risk and resultant risk in terms of understanding the nature of risk. Behavioral a worthlessness theory believes that danger should be an attribute of behavior, the judgment of danger should be based on prior standards, and the objective facts at the time of the behavior and the subjective knowledge of the actor at that time should be used as the basis for judgment; the result agnosticism: the danger originates from the result of the behavior, and the specific situation produced by the behavior is used as the basis for behavior judgment. The risk theory of behavior attribute judges the possible harm caused by a criminal act to an object based on specific facts and behaviors as the object of judgment; as a result, the risk theory believes that danger is an objective state of actual existence, not only to determine whether the danger exists, but also to determine the degree to which the danger exists. Whether it is a possibility or a high probability, and the degree of a high probability of identifying a danger is used as the basis for punishing crimes, which also provides a classification basis for the data mining model [13]. The degree of specific danger has reached a certain standard, which is the necessary condition for the establishment of an abstract dangerous crime; the fact that the specific danger has a very serious degree is the

prerequisite for the establishment of a specific dangerous crime, which is also a necessary condition in the legal data mining model. For the specific circumstances of the behavior at the time, the degree of specific danger should be determined according to the judgment of the general public [14]. The potential danger of carrying out acts against specific legal interests of specific dangers materializes into a critical situation. The typical danger arising from a specific behavior should be based on the characteristics of the specific case to examine the existence of the specific danger, rather than relying on general experience to judge. These various behaviors are difficult to judge by the way of thinking, and the amount of data is huge. This problem can be effectively solved by data mining algorithm [15]. Literature [16] pointed out that the following consensus has been formed in modern criminal policy regarding the handling of crimes: first, legislation is to avoid unnecessary behaviors as crimes, to ensure that the seriousness of punishment is accepted by ordinary people, and the criminal law establishes criminal behaviors. It should only be limited to the minimum range necessary to maintain social public order; secondly, citizens' loyalty to the law should far outweigh their preference for criminalism, if people are still guilty of crimes that are detrimental to the order maintained by the law. If the public security is endured enough, then public safety should not be evaluated as a threat in the criminal law; thirdly, for minor crimes, a summary procedure should be applied to entrust administrative agencies to deal with them, while judicial agencies should focus on dealing with more serious crimes. Classification conditions can effectively solve these problems.

This paper uses the mining algorithm to analyze legal issues of the crime of endangering public safety problem, builds an intelligent analysis model, and promotes the research efficiency of legal issues of the crime of endangering public safety problem.

2. Improvement of Mining Algorithm for Legal

2.1. Wave Function Form of Edge State and Its Evolution.

This paper improves the algorithm based on the actual needs of legal mining. When the Hamiltonian solves its duration equation to get the eigenvalues, the zero-energy solution can be found in the case of open boundaries. In this section, we will see the wave function characteristics of the zero-energy solution, which satisfies the large amplitude at both ends of the chain and then decays toward the middle power series of the chain. Therefore, we call such a state an edge state, and the corresponding other non-zero-energy eigenstates are body states.

The dynamic defect generation in a one-dimensional topological model with periodic boundary conditions is analytically calculated using the Fourier transform and the LZ transition mechanism. But under finite-length open-boundary conditions, it is no longer possible to use the Fourier transform to decouple the different k . This makes the analysis more difficult to calculate, there is a non-negligible coupling between the energy levels, and the two-level situation can no longer be used for analysis. When $J_0 = -1$ is

fixed, the uniform modulation of J_1 is from -5 to 5 , the entire evolution process. The time is 2τ , that is, $J_1 = 5t/\tau$, and the numerical calculation of defect density of $N = 200$ is shown in Figure 1. It can be seen from the figure that the defect density after the superposition of bulk and edge states produces periodic oscillations.

Among them, the body state is diffuse in real space, while the edge state has strong locality.

First, we write the duration equation for the Hamiltonian:

$$H|\phi_n\rangle = E_n|\phi_n\rangle = 0. \quad (1)$$

Among them, the eigenstate is

$$|\phi_n\rangle = \sum_n c_n |n\rangle. \quad (2)$$

When solving this equation, due to the special symmetry of the Hamiltonian, we can obtain the recurrence relation:

$$\begin{aligned} J_0 c_{2l-1} + J_1 c_{2l+1} + J_3 c_{2l+3} &= 0, \\ J_0 c_{2l} + J_1 c_{2l-2} + J_3 c_{2l-4} &= 0. \end{aligned} \quad (3)$$

The odd-numbered and even-numbered lattice points satisfy the recurrence relation and actually correspond to the two decoupled Majorana modes that can be obtained after the transformation of the Hamiltonian.

When $J_0 = -1$ is fixed, the uniform modulation of J_1 is from -5 to 5 , the entire evolution process. The time is 2τ . For the finite number of lattice points, considering the boundary conditions, the equation has no solution. Only in the limit of $N \rightarrow \infty$ can there be a strict zero-energy solution. When N is finite, we can get solutions very close to zero energy. In the limit of $N \rightarrow \infty$, the recurrence relation has the characteristic equation:

$$J_0 + J_1 q + J_3 q^3 = 0. \quad (4)$$

This characteristic equation means that the coefficients of the wave function satisfy the relation of the proportional sequence. This quadratic equation can be solved:

$$q_{\pm} = \frac{-J_1 \pm \sqrt{J_1^2 - 4J_0J_3}}{2J_3}. \quad (5)$$

According to the two solutions of the characteristic equation, the coefficients of the eigenstate can be obtained:

$$c_{2l-1} = C_1 q_+^l + C_2 q_-^l. \quad (6)$$

Since our model is the long-chain large- N limit, it must satisfy $|q_{\pm}| \leq 1$. The even-numbered characteristic equations are obviously symmetrical to the odd-numbered ones, and the difference is that they are arranged in equal proportions from the other end of the chain inward. Such symmetry guarantees the consistency of the wave functions of the two degenerate zero-energy edge states. Moreover, they are arranged according to the same ratio of power series decay at odd (1, 3, 5) and even grid points ($\dots N-4, N-2, N$), respectively.

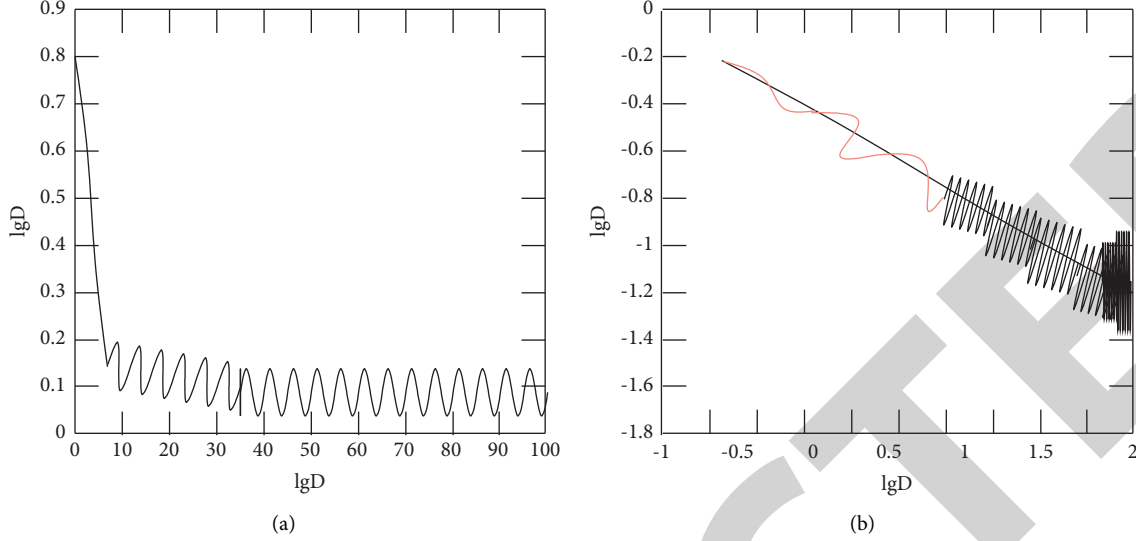


FIGURE 1: The relationship between defect generation and time under open-boundary conditions. When the initial state is $J_1 = -5$, the full lower-band body state and the two degenerate edge states are equally weighted superposition.

Using the summation formula of the proportional series, we can normalize the obtained marginal state distribution. Under the given conditions of $J_3 = 1$ and $J_0 = -1, J_1 < 0$, we can obtain two edge states:

$$\begin{aligned}
 |\phi_{\text{odd}}\rangle &= \sqrt{1-q^2} \sum_{l=1} q^{l-1} |2l-1\rangle, \\
 |\phi_{\text{even}}\rangle &= \sqrt{1-q^2} \sum_{l=1} q^{l-1} |N-2l+2\rangle, \\
 q &= \frac{-J_1 - \sqrt{J_1^2 + 4}}{2}.
 \end{aligned} \tag{7}$$

Any state in the subspace spanned by these two edge states can be written as

$$|\varphi\rangle = \alpha|\phi_{\text{odd}}\rangle + \beta|\phi_{\text{even}}\rangle. \tag{8}$$

For the double degeneracy, according to the Wilczek-Zee theory, the evolution relation of the coefficients in formula (8) is

$$\langle \phi_{\text{odd}} | \partial_t | \phi_{\text{even}} \rangle = 0,$$

$$\begin{aligned}
 \langle \phi_{\text{odd}} | \partial_t | \phi_{\text{odd}} \rangle &= \langle \phi_{\text{odd}} | \frac{\partial q}{\partial t} \frac{\partial}{\partial q} | \phi_{\text{odd}} \rangle = -\frac{5}{2\pi} \left(1 + \frac{J_1}{\sqrt{J_1^2 + 4}} \right) \langle \phi_{\text{odd}} | \frac{\partial}{\partial q} | \phi_{\text{odd}} \rangle, \\
 &= -\frac{5}{2\pi} \left(1 + \frac{J_1}{\sqrt{J_1^2 + 4}} \right) \left[\frac{-q}{1-q^2} + (1-q^2) \sum_{l=1} l q^{2l-1} \right] = 0 \\
 &= \langle \phi_{\text{even}} | \partial_t | \phi_{\text{even}} \rangle.
 \end{aligned} \tag{12}$$

$$M \cdot \partial_t \begin{bmatrix} \alpha \\ \beta \end{bmatrix} = \Lambda \begin{bmatrix} \alpha \\ \beta \end{bmatrix}. \tag{9}$$

Among them,

$$\begin{aligned}
 M &= \begin{bmatrix} \langle \phi_{\text{odd}} | \phi_{\text{odd}} \rangle & \langle \phi_{\text{odd}} | \phi_{\text{even}} \rangle \\ \langle \phi_{\text{even}} | \phi_{\text{odd}} \rangle & \langle \phi_{\text{even}} | \phi_{\text{even}} \rangle \end{bmatrix}, \\
 \Lambda &= - \begin{bmatrix} \langle \phi_{\text{odd}} | \partial_t | \phi_{\text{odd}} \rangle & \langle \phi_{\text{odd}} | \partial_t | \phi_{\text{even}} \rangle \\ \langle \phi_{\text{even}} | \partial_t | \phi_{\text{odd}} \rangle & \langle \phi_{\text{even}} | \partial_t | \phi_{\text{even}} \rangle \end{bmatrix}.
 \end{aligned} \tag{10}$$

According to Expression 7 of the edge state, we can get

$$\begin{aligned}
 \langle \phi_{\text{odd}} | \phi_{\text{odd}} \rangle &= \langle \phi_{\text{even}} | \phi_{\text{even}} \rangle = 1, \\
 \langle \phi_{\text{odd}} | \phi_{\text{even}} \rangle &= 0.
 \end{aligned} \tag{11}$$

In addition to this, there is an inner product that includes the derivative.

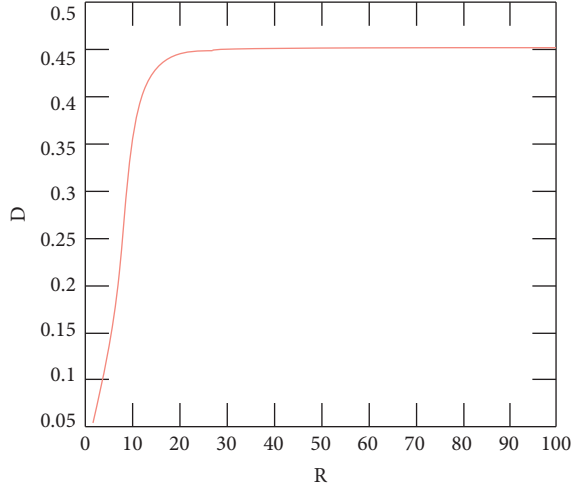


FIGURE 2: The relationship between defect density of edge states and training time. $N=200$, $J_0=-1$, $J_3=1$, $J_1=5t/\tau$, $-\tau \leq t \leq \tau$ is uniform modulation, and the initial state is equal-weight superposition of edge states of odd and even lattice points.

Among them, the sequence at the long-chain limit is summed:

$$\lim_{n \rightarrow \infty} \sum_{l=1}^n l q^{2l-1} = \frac{q}{(1-q^2)^2}. \quad (13)$$

After the evolution matrix is determined by these values, we can get

$$\partial_t \begin{bmatrix} \alpha \\ \beta \end{bmatrix} = 0. \quad (14)$$

This means that after we choose a state that is superimposed by two edge states, the coefficients of this state on the two edge states are fixed over time. When the initial state is $|\phi_{\text{odd}}\rangle$ or $|\phi_{\text{even}}\rangle$, it always evolves along that eigenstate, and no additional phase is generated when the initial state is the superposition of the two.

Now, we examine the survival of edge states after evolution under the KZ paradigm. According to the above discussion, we can find the edge states for $J_1 < 0$ and $J_1 > 0$ cases, respectively. We denote the side of $t < 0$ as $s\hat{q}$ and the side of $t > 0$ as \hat{q}' . Under the condition that the modulus of the two is guaranteed to be less than 1,

$$\begin{aligned} \hat{q}_- &= \frac{-J_1 - \sqrt{J_1^2 + 4}}{2}, \\ \hat{q}'_+ &= \frac{-J_1 + \sqrt{J_1^2 + 4}}{2}. \end{aligned} \quad (15)$$

We denote the value of the two boundary parameters of morality-law as $J_1 = \mp \hat{J}_1$. When it is substituted into formula (15), there is $\hat{q}' = -\hat{q}$.

The size of the inner product of the edge states on both sides of the legal region is

$$\begin{aligned} \langle \phi_{\text{odd}}(-\hat{t}) | \phi_{\text{odd}}(\hat{t}) \rangle &= (1 - \hat{q}^2) \sum_{l=1}^{\hat{t}} (-\hat{q}^2)^{l-1} \\ &= \frac{1 - \hat{q}^{2\hat{t}}}{1 + \hat{q}^2}. \end{aligned} \quad (16)$$

When the evolution speed is very fast, that is, when $\tau \rightarrow 0$, the legal area is very large, $\hat{q} \rightarrow 0$, and $\langle \phi_{\text{odd}}(-\hat{t}) | \phi_{\text{odd}}(\hat{t}) \rangle \rightarrow 1$ in formula (16) can be obtained. On the contrary, if $\tau \rightarrow \infty$, $\langle \phi_{\text{odd}}(-\hat{t}) | \phi_{\text{odd}}(\hat{t}) \rangle \rightarrow 0$. That is, in faster evolution, the survival rate of edge states is higher, and the defect rate caused by edge states is lower. In very slow evolution (moral evolution), the survival rate of edge states is rather low, and thus the defect rate caused by edge states is high. This is also contrary to the expectation of the defect of the KZ mechanism in the general sense. The defect density of the edge states is shown in Figure 2.

When the system is far from the phase transition point, the mutual coupling can be ignored due to the large energy-level difference, so the relationship between the body state and the edge state can be approximately regarded as the moral evolution. For the moral system, we write the Schrödinger equation:

$$i \frac{d}{dt} |\Psi(t)\rangle = H(t) |\Psi(t)\rangle. \quad (17)$$

The eigenvalue equation that satisfies the Hamiltonian for the eigenstate $|\phi_n(t)\rangle$ is

$$H(t) |\phi_n(t)\rangle = E_n(t) |\phi_n(t)\rangle. \quad (18)$$

In these two equations, the Hamiltonian is time-dependent. The general solution to the Schrödinger equation can be written as a linear superposition of $|\phi_n(t)\rangle$ with phase:

$$|\Psi(t)\rangle = \sum_n c_n(t) e^{-i \int_0^t E_n(\tau) d\tau} |\phi_n(t)\rangle. \quad (19)$$

The time-dependent coefficient $c_n(t)$ can be found as follows:

$$\begin{aligned} i \frac{d}{dt} |\Psi(t)\rangle &= i \sum_n [c'_n(t) |\phi_n(t)\rangle + c_n(t) |\phi'_n(t)\rangle] \exp \left[-i \int_0^t E_n(\tau) d\tau \right] \\ &\quad + \sum_n c_n(t) E_n(t) |\phi_n(t)\rangle \exp \left[-i \int_0^t E_n(\tau) d\tau \right] \\ &= i \sum_n [c'_n(t) |\phi_n(t)\rangle + c_n(t) |\phi'_n(t)\rangle] \exp \left[-i \int_0^t E_n(\tau) d\tau \right] \\ &\quad + \sum_n c_n(t) H(t) |\phi_n(t)\rangle \exp \left[-i \int_0^t E_n(\tau) d\tau \right] \\ &= H(t) |\Psi(t)\rangle + i \sum_n [c'_n(t) |\phi_n(t)\rangle + c_n(t) |\phi'_n(t)\rangle] \exp \left[-i \int_0^t E_n(\tau) d\tau \right]. \end{aligned} \quad (20)$$

Comparing with the time-dependent Schrödinger equation, we can get

$$i \sum_n [c_n(t)|\phi_n(t)\rangle + c_n(t)|\dot{\phi}_n(t)\rangle] \exp\left[-i \int_0^t E_n(\tau) d\tau\right] = 0. \quad (21)$$

The coefficients can be found using formula (21):

$$\begin{aligned} \dot{c}_m(t) &= - \sum_n c_n(t) |\phi_m(t)\rangle |\dot{\phi}_n(t)\rangle \\ &\exp\left[i \int_0^t E_m(\tau) d\tau - i \int_0^t E_n(\tau) d\tau\right]. \end{aligned} \quad (22)$$

Among them, $\langle \phi_m(t) | \dot{\phi}_n(t) \rangle$ can be found using the derivative of the eigenequation:

$$\dot{H}(t)|\phi_n(t)\rangle + H(t)|\dot{\phi}_n(t)\rangle = E_n(t)|\phi_n(t)\rangle + E_n(t)|\dot{\phi}_n(t)\rangle. \quad (23)$$

Taking the inner product of formula (23) and $|\phi_m(t)\rangle$, we get

$$\begin{aligned} \langle \phi_m(t) | \dot{H}(t) | \phi_n(t) \rangle + E_m(t) \langle \phi_m(t) | \dot{\phi}_n(t) \rangle \\ = E_n(t) \delta_{nm} + E_n(t) \langle \phi_m(t) | \dot{\phi}_n(t) \rangle. \end{aligned} \quad (24)$$

For $m \neq n$, after shifting the term, we get

$$\langle \phi_m(t) | \dot{\phi}_n(t) \rangle = \frac{\langle \phi_m(t) | \dot{H}(t) | \phi_n(t) \rangle}{E_n(t) - E_m(t)}, m \neq n. \quad (25)$$

From this, the differential equation obeyed by $C_m(t)$ is obtained:

$$\begin{aligned} \dot{c}_m(t) &= -c_m \langle \phi_m(t) | \dot{\phi}_m(t) \rangle \\ &- \sum_{n \neq m} c_n(t) \frac{\langle \phi_m(t) | \dot{H}(t) | \phi_n(t) \rangle}{E_n(t) - E_m(t)} \exp\left[-i \int_0^t [E_n(\tau) - E_m(\tau)] d\tau\right]. \end{aligned} \quad (26)$$

The solution to the Schrodinger equation in formula (26) is still exact. We perform a moral approximation:

$$\left\| \frac{1}{E_n(t) - E_m(t)} \frac{\langle \phi_m(t) | \dot{H}(t) | \phi_n(t) \rangle}{\langle \phi_m(t) | H(t) | \phi_n(t) \rangle} \right\| \ll 1. \quad (27)$$

Under the inequality conditions of this moral approximation, we can get

$$\dot{c}_m(t) \approx -c_m(t) \langle \phi_m(t) | \dot{\phi}_m(t) \rangle. \quad (28)$$

The general solution to differential equation (28) is

$$\begin{aligned} c_m(t) &= c_m(0) e^{i\gamma_m(0,t)}, \\ \gamma_m(0,t) &= i \int_0^t \langle \phi_m(t) | \dot{\phi}_m(t) \rangle d\tau. \end{aligned} \quad (29)$$

Finally, we can get the time-dependent moral evolution equation:

$$|\Psi(t)\rangle \approx \sum_m c_m(0) |\phi_m(t)\rangle \exp\left[i\gamma_m(0,t) - i \int_0^t E_m(\tau) d\tau\right]. \quad (30)$$

If the initial state of the wave function of the system is assumed to be the n th eigenstate, that is, $c_m(0) = \delta_{nm}$, we can get

$$|\Psi(t)\rangle \approx |\phi_n(t)\rangle \exp\left[i\gamma_n(0,t) - i \int_0^t E_n(\tau) d\tau\right]. \quad (31)$$

According to the moral evolution formula (30), we can write the phase difference between the wave function and the initial state in the process of moral evolution.

2.2. Bulk Defect Density for Open Boundaries. In the open-boundary case of finite-length chains, the Hamiltonian cannot be decoupled in k -space. The body energy levels are no longer decoupled from each other, and the transition probability of a single energy level can no longer be described by the LZ formula. We select the energy levels with the same numbers as the periodic boundary conditions and numerically calculate their transition probabilities for comparison.

In addition to this factor, the different energy-level connection structures of the system are also different from that of the periodic boundary. The band top of the negative energy band and the band bottom of the positive energy band are both connected to the edge states on the other side of the phase transition point, and there is a mutual energy-level crossing. This undoubtedly makes the transition process incompatible with the LZ formula.

As can be seen in Figure 3, the transition probability of single-level behavior still conforms to the exponential form of $e^{\delta\tau}$, but the coefficient 8 in the exponent cannot be directly determined because there is a certain probability of transition to other energy-level pairs and edge states. We can refer to the calculation method at the periodic boundary, extract the energy gap size between a certain energy level and its symmetric energy level from the energy spectrum, and then substitute it into the LZ formula. The transition probability at the periodic boundary is completely consistent with the LZ formula, but under the condition of open boundary, the half of the minimum energy gap of No. 98, 90, and 80 and their symmetric energy levels are 0.093, 0.341, and 0.642, respectively. Their squares are clearly not proportional to the slopes in the natural logarithm plot and are far from the periodic boundaries.

According to the analysis of the KZ paradigm, we can easily know that for the nonequilibrium evolution process, the system wave function change can be divided into three evolution intervals, namely, morality-law-morality. The wave function of the system is approximately assumed to be

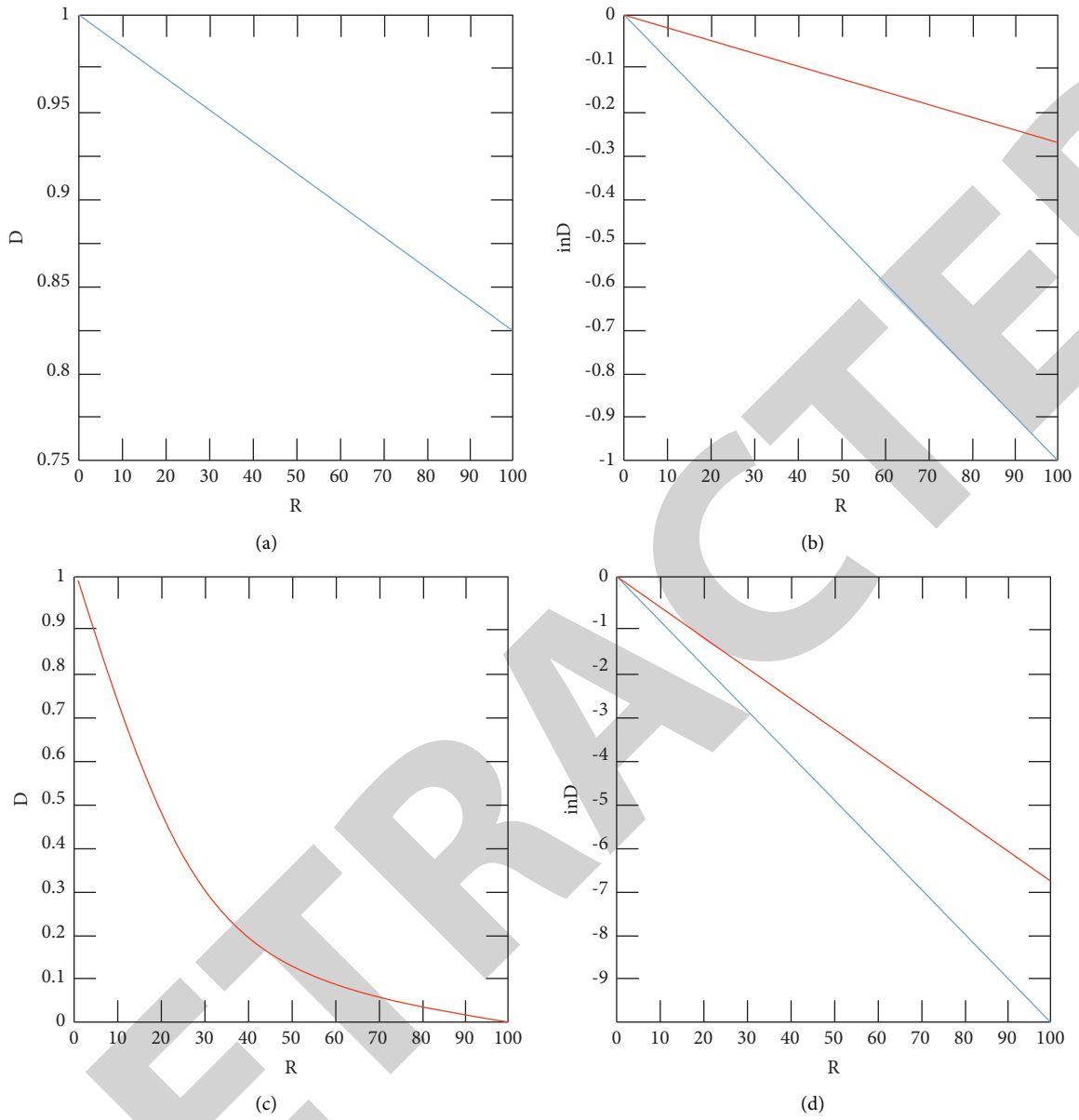


FIGURE 3: Continued.

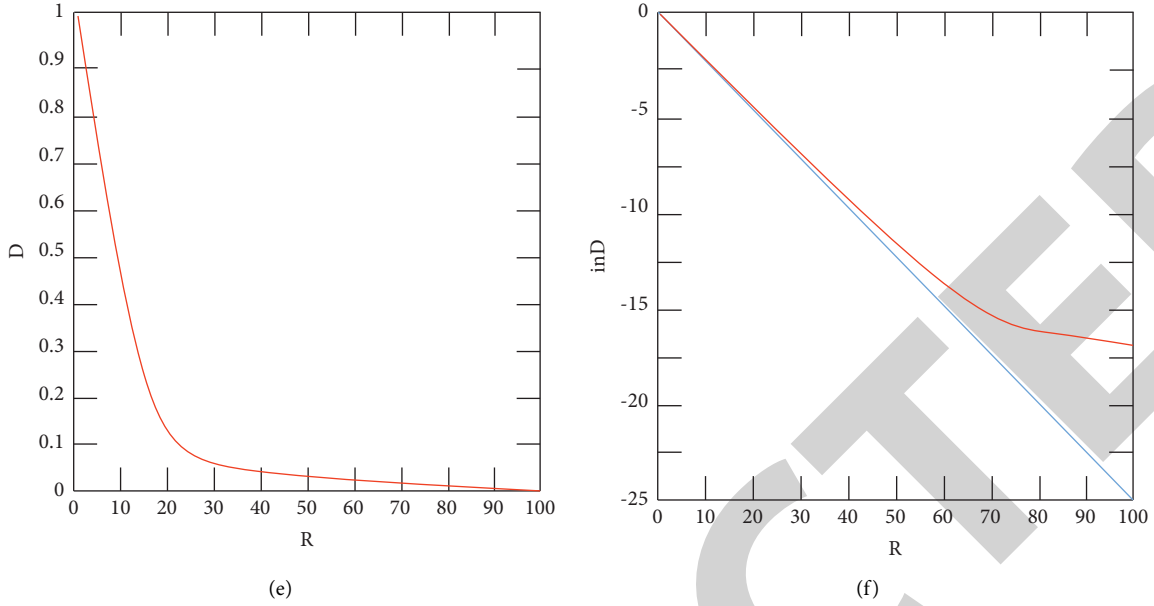


FIGURE 3: The relationship between single-level evolution defect density and training time τ with open-boundary condition; the parameter settings are the same as Figure 4. $N=200$, $J_0=-1$, $J_3=1$, $J_1=5t/\tau$, $-\tau \leq t \leq \tau$ is uniform modulation. (a) and (b) The blue line is the defect density and logarithm of level 98 under open-boundary condition, and the red line is the logarithm of defect at level 98 under periodic boundary condition. (c) and (d) correspond to energy level 90, (e) and (f) correspond to energy level 80, and other parameters are the same as (a).

unchanged within the legal interval. However, in the two moral intervals of $t < -\hat{t}$ and $t > \hat{t}$, starting from the initial state of an eigenstate, the system evolves along the eigenstate and gradually changes the phase of the wave function. In the usual case, the calculation of defect density involves only modulo squares, and such a phase is not valid. However, it will be seen later that when it comes to the evolution of edge states, the calculation of defect density will include interference terms with explicit phase. The respective phases of the edge state and the bulk state determine the oscillation characteristics of the defect density. Figure 4 shows a numerically calculated defect density image of the body state.

We analyze the posture and approximate the law in the KZ paradigm using the moral evolution formula, and we can get

$$\begin{aligned}
 |\text{Bulk}(\tau)\rangle &= \sum_{l=1}^N e^{-i \int_{\hat{t}}^{\tau} E_l(t) dt} \cdot e^{i\gamma_l(\hat{t}, \tau)} \\
 &\left[\sum_m c_m(-\tau) \cdot e^{-i \int_{-\tau}^{-\hat{t}} E_m(t) dt} \cdot e^{i\gamma_m(-\tau, -\hat{t})} \cdot \langle \phi_l(\hat{t}) | \phi_m(-\hat{t}) \rangle \cdot |\phi_l(\tau)\rangle \right]
 \end{aligned} \quad (32)$$

Among them, $c_m(-\tau)$ is the distribution of the system wave function in each eigenstate at the beginning of the evolution, and we take it as the equal-weight superposition of each energy level in the negative energy band. The expression here writes that the state vector is phased when going through the moral process, and the coefficients when the new eigenstate is the basis vector are redistributed through the inner product term in the legal interval.

Since our Hamiltonian is a real matrix, $\langle \phi_l | n \rangle$ is a real number, and using $1 = \sum_n |n\rangle \langle n|$, we can get the geometric phase to be 0 in formula (32):

$$\begin{aligned}
 \gamma_l &= \int \langle \phi_l | \dot{\phi}_l \rangle dt = \int \langle \phi_l | d | \phi_l \rangle \\
 &= \sum_n \int \langle \phi_l | n \rangle \langle n | d | \phi_l \rangle \\
 &= \int \sum_n \frac{1}{2} d |\langle \phi_l | n \rangle|^2 \\
 &= 0.
 \end{aligned} \quad (33)$$

The energy spectrum made by the Hamiltonian has a relatively obvious feature that can be used to simplify the calculation of the integral. Therefore, it is analytically complicated to perform transition processing between multiple energy levels. Considering the relative regularity of our energy spectrum structure, in the far-side moral region where the phase contribution is relatively large, the energy levels in the upper and lower energy bands are very dense, and the form approximates a linear function proportional to the modulation parameter. Moreover, the larger contribution to the transition comes from the energy levels closer to the band top and bottom. Therefore, the upper and lower energy bands can be regarded as one energy level for simplified calculation. Specifically, for the training process where the initial and final positions of J_1 are -5 to 5 , the expression for the energy in the upper energy band component in formula (32) can be written as

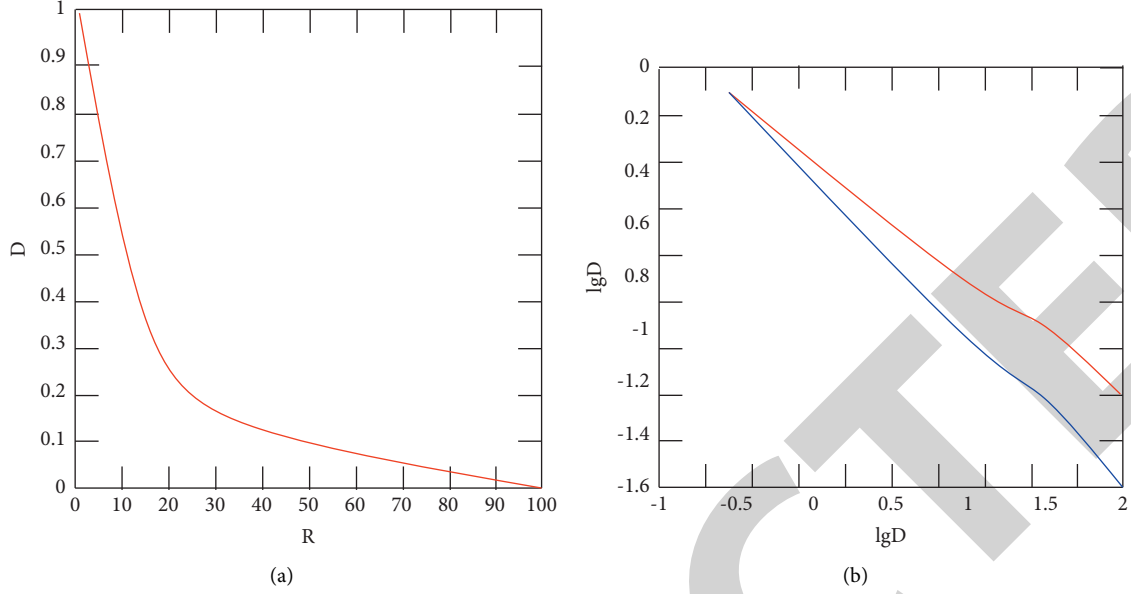


FIGURE 4: The relationship between defect density and training time of body postures under open-boundary conditions. $N=200$, $J_0=-1$, $J_3=1$, $J_1=5t/\tau$, $-\tau \leq t \leq \tau$ is a uniform modulation, and the initial state is an equal-weight superposition of all lower energy band states.

$$E_n(t) \sim \frac{5t}{\tau}. \quad (34)$$

After the energy is no longer related to the energy-level number, it can be taken from the summation as the common phase. When it is substituted into formula (32), we can get component of the desired state in the positive energy band:

$$|\text{Bulk}^+(\tau)\rangle \sim \frac{1}{\sqrt{N/2-1}} e^{i\theta_1} \cdot e^{i\theta_2} \sum_l \sum_{m=1}^{N/2-1} \langle \phi_l(\hat{t}) | \phi_m(-\hat{t}) \rangle | \phi_l(\tau) \rangle, \quad (35)$$

$$\theta_1 = \frac{5}{2} \left(\tau - \frac{\hat{t}^2}{\tau} \right),$$

$$\theta_2 = \frac{5}{2} \left(\tau - \frac{\hat{t}^2}{\tau} \right).$$

It can be seen that the phase sum contributed by the moral evolution on the left and right sides of the phase transition point is 0, and finally the positive energy band component part of the posture under the KZ paradigm can be obtained:

$$|\text{Bulk}^+(\tau)\rangle \sim \frac{1}{\sqrt{N/2-1}} \sum_{l=N/2+1}^N \sum_{m=1}^{N/2-1} \langle \phi_l(\hat{t}) | \phi_m(-\hat{t}) \rangle | \phi_l(\tau) \rangle. \quad (36)$$

For the classical phase transition, the relaxation time $t_R(\hat{t}) = \chi \hat{t}$, $\chi = O(1)$ is proposed. The relaxation time is proportional to the inverse of the energy gap, while the energy is approximately linear in the equation. The coefficient β can be found such that

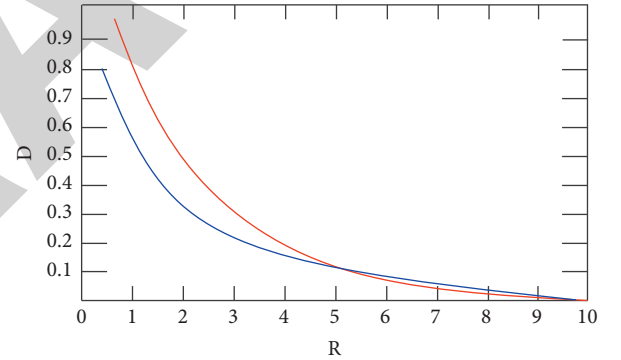


FIGURE 5: Schematic diagram of the generation of defect density over time. The red is the kinetic evolution value, the blue is the KZ paradigm fitting value, and other parameters are the same as Figure 4.

$$\hat{t} = \sqrt{\frac{\tau}{\beta}}. \quad (37)$$

According to these results, the defect density expression in the KZ paradigm can be determined as

$$D \sim \frac{1}{N/2-1} \sum_{l=N/2+2}^N \sum_{m=1}^{N/2-1} \left| \left\langle \phi_l \left(\sqrt{\frac{\tau}{\beta}} \right) \middle| \phi_m \left(-\sqrt{\frac{\tau}{\beta}} \right) \right\rangle \right|^2. \quad (38)$$

We can determine the value of β by fitting with the evolution results of the kinetic equation. The main interval of defect density generation can be seen in the figure as τ in the range of 1 to 10. We fit β by minimum variance in this interval and get $\beta=32.11$. Figure 5 shows a comparison

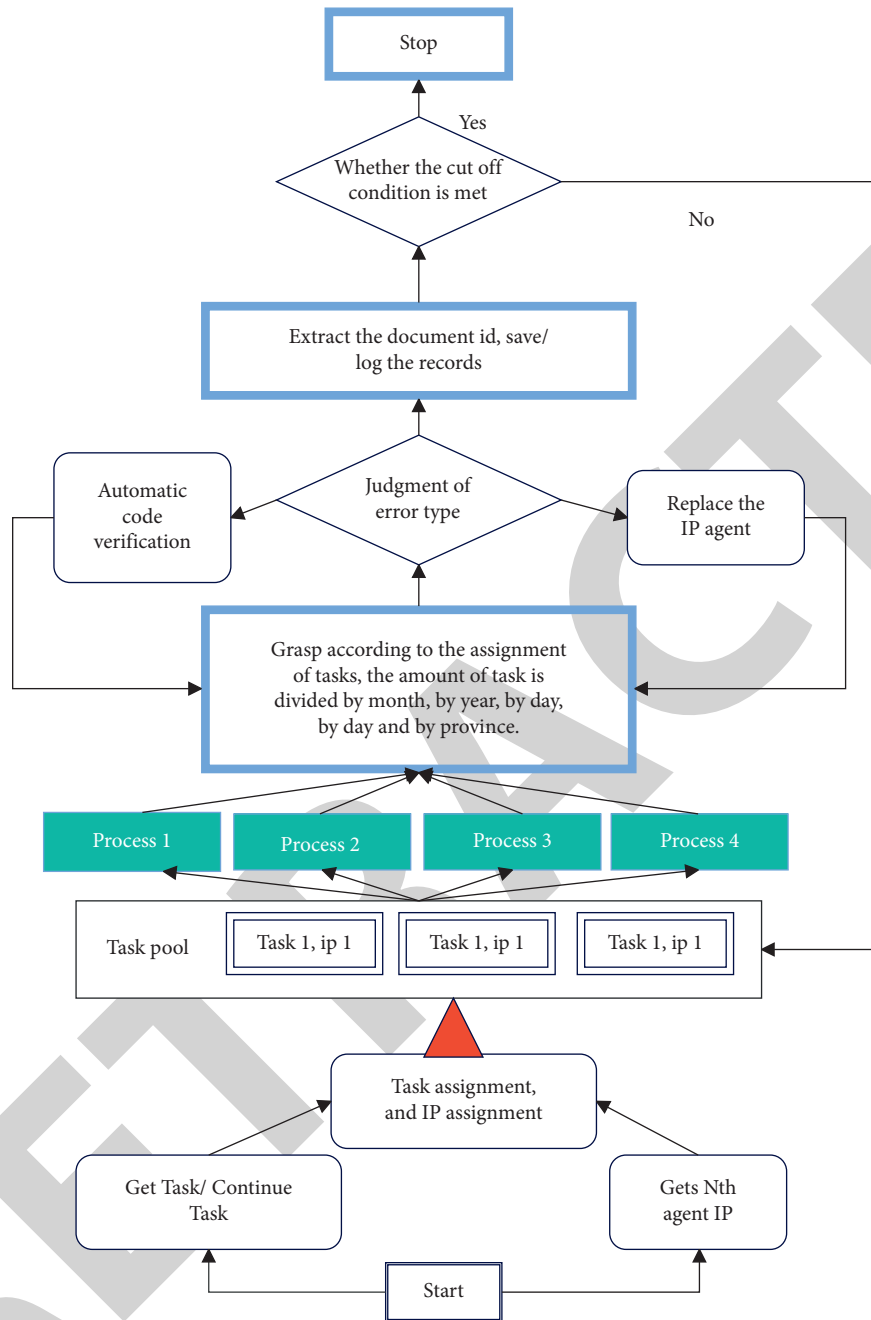


FIGURE 6: Legal document id acquisition module.

diagram of the defect density between the KZ paradigm of the bulk state and the dynamic evolution.

The fidelity is $F = |\langle \Psi(-\hat{t}) | \Psi(\hat{t}) \rangle|^2$, which measures the “freezing” of the system state in the legal area. When the value of τ does not exceed 10, the fidelity of $\beta = 32.11$ is greater than 0.5. It can be seen that the error source of the KZ paradigm mainly comes from the legal area during the slow training process and mainly from the moral area during the fast training process.

3. Analysis of Legal Problems of the Crime of Endangering Public Safety Based on Data Mining Algorithm

The algorithm of the second part is applied to the mining of legal problems of the crime of endangering public safety. This article assigns a dynamic IP to each process, mainly to prevent access to too many IPs from being restricted. Each process is captured according to the magnitude of the

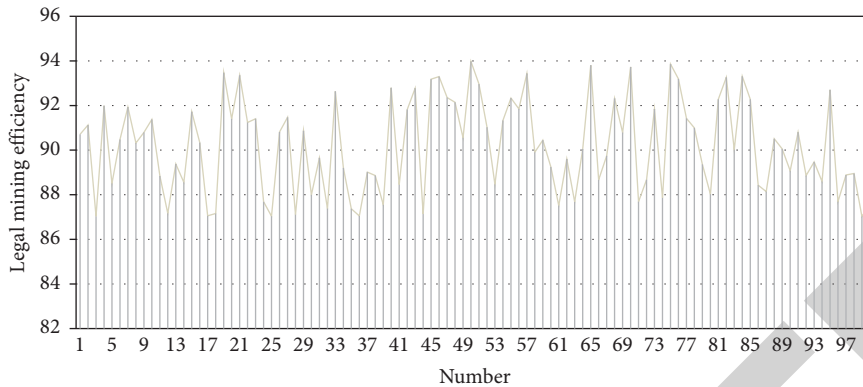


FIGURE 7: The mining effect of the legal issues of the crime of endangering public safety.

assigned task, which can be divided into monthly, yearly, daily, and provincial captures. For the problem of too many visits, the method adopted is to perform automatic code verification and continue to download after the verification is successful. Secondly, for the IP proxy error, the method taken is to replace the IP proxy and download it again. In addition, for other errors, the strategy is to record the detailed information of the error through the error log and make a record for the subsequent catch-up. After downloading the document, the document id in the extracted document is extracted, the extraction method adopts a rule-based method, and the extracted id is stored in the file to prepare for the subsequent document download. Finally, it is judged whether to end the crawling by whether the task pool is empty. The legal document id acquisition module is shown in Figure 6.

This paper verifies the mining effect of the legal problem of the crime of endangering public safety with the model proposed in this paper, and the statistical verification results are shown in Figure 7.

Through the above simulation research, we can see that the legal problem analysis model of the crime of endangering public safety based on the data mining algorithm proposed in this paper has a good legal data mining effect. Therefore, the model in this paper can be applied to the mining and analysis of legal issues of the crime of endangering public safety.

4. Conclusion

With the increasing number of cases of crime of endangering public safety by dangerous means, the controversy of the crime in the academic circle is also increasing, mainly focusing on the “pocket crime” tendency of the crime. In fact, there are specific reasons why the crime is in the present situation. Although public opinion cannot lead the judiciary, it can influence the judiciary. The fundamental reason for the over-expansion of the crime of endangering public safety by dangerous means in trial practice is that the utilitarian demand for punishing the crime can be met by the sentence of the crime, and it is public opinion that drives this demand. In the face of the impact of public opinion, the judiciary should remain neutral, and the law should guide public

opinion rather than the other way around. This paper analyzes the legal issues of the crime of endangering public safety combined with the actual mining algorithm and builds an intelligent analysis model to promote the research efficiency of the crime of endangering public safety.

Data Availability

The labeled dataset used to support the findings of this study can be obtained from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] F. S. Hussain and A. F. Aljuboori, “Survey on crime analysis using data mining based on mobile platforms,” *Journal of Al-Qadisiyah for Computer Science and Mathematics*, vol. 13, no. 1, pp. 36–45, 2021.
- [2] M. R. Khatun, S. I. Ayon, M. R. Hossain, and M. J. Alam, “Data mining technique to analyse and predict crime using crime categories and arrest records,” *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 22, no. 2, pp. 1052–1058, 2021.
- [3] S. Mangara Wainana, J. Njuguna Karomo, R. Kyalo, and N. Mutai, “Using data mining techniques and r software to analyze crime data in Kenya,” *International Journal of Data Science and Analysis*, vol. 6, no. 1, pp. 20–28, 2020.
- [4] S. Zith, D. Babu, and H. H. Syed, “An overview of a crime detection system using the art of data mining,” *SSRN Electronic Journal*, vol. 7, no. 5, pp. 125–128, 2020.
- [5] N. Pokhriyal, N. Kumar, R. Verma, and A. Semwal, “Survey on crime data analysis using a different approach of k-means clustering,” *International Journal of Advanced Science and Technology*, vol. 29, no. 5, Article ID 13839, 2020.
- [6] F. Faisal and D. P. Rahayu, “Countermeasure policy on mining crime under the legal progressive perspective,” *Yustisia Jurnal Hukum*, vol. 10, no. 2, pp. 226–234, 2021.
- [7] L. Suriani, “Pengelompokan data kriminal pada poldasu menentukan pola daerah rawan tindak kriminal menggunakan data mining algoritma k-means clustering,” *Jurnal Sistem Komputer Dan Informatika (JSON)*, vol. 1, no. 2, pp. 151–158, 2020.

Retraction

Retracted: Prediction of Higher Education Cost and Analysis of Sharing Ability Based on Artificial Neural Network

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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] Z. Xia, X. Yue, F. Niu, and Z. Hu, "Prediction of Higher Education Cost and Analysis of Sharing Ability Based on Artificial Neural Network," *Security and Communication Networks*, vol. 2022, Article ID 7649918, 11 pages, 2022.

Research Article

Prediction of Higher Education Cost and Analysis of Sharing Ability Based on Artificial Neural Network

Zilong Xia, Xin Yue, FanChao Niu, and Zihua Hu 

Chengdu Technological University, Chengdu 610000, China

Correspondence should be addressed to Zihua Hu; hzhua1@cdu.edu.cn

Received 20 June 2022; Revised 22 July 2022; Accepted 11 August 2022; Published 16 September 2022

Academic Editor: Tao Cui

Copyright © 2022 Zilong Xia et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

In order to explore how to realize the cost prediction and sharing ability of higher education, this paper proposes an analysis of the cost prediction and sharing ability of higher education based on artificial neural network. This method explores how to realize the cost prediction of higher education through the key technical problems and solutions of information recommendation based on artificial neural network. The research shows that the ability of college education cost prediction and sharing based on artificial neural network is 61% higher than that of traditional cost prediction and sharing. With the help of BP neural network algorithm, the accuracy of cost prediction can be maintained above 90%. It is proved that the artificial neural network algorithm can effectively improve the cost forecasting, financial system, and cost management system of colleges and universities.

1. Introduction

The development of science and technology and the success of society have affected all areas of life to varying degrees and improved the environment of colleges and universities, and the colleges have also undergone earth-shaking changes. The development of higher education has entered an unprecedented new situation [1]. In recent years, with the further support of teaching activities in colleges and universities in my country, such activities have become more and more difficult, and there are more and more jobs. Capital spending by colleges and universities also showed some improvement. This also makes colleges and universities pay more and more money for supervision and management [2]. Higher education cost management and accounting is very important and even becomes an important component of financial management in colleges and universities. Therefore, on the basis of cost accounting, on the basis of clarifying the dependent variables and independent variables of university cost control, cost accounting, and cost sharing ability, combined with neural network algorithm, this paper has made a key research on cost prediction [3].

Internet education is about the application of information technology in education (educational management,

teaching research) and the promotion of education and training through the development and implementation of educational materials. Its technical characteristics are digitalization, networking, intelligence, and multimedia. Its basic characteristics are openness, sharing, interaction, and cooperation. Internet education is used to promote educational modernization, and information technology is used to change the traditional mode [4]. Compared with traditional models, online learning has advantages in data transfer, data quality, data rate, and data exchange as shown in Figure 1.

2. Literature Review

With the prevalence of cost sharing theory in the field of higher education, since 1990, the subject of cost sharing in American higher education has shifted from the government to other subjects [5]. First is the university itself. American universities invest in the capital market by actively participating in scientific research projects cooperating with enterprises, establishing science and technology parks, establishing companies, applying for patents, venture capital, etc.; secondly, students pay tuition fees, especially private nonprofit universities, whose tuition level and the

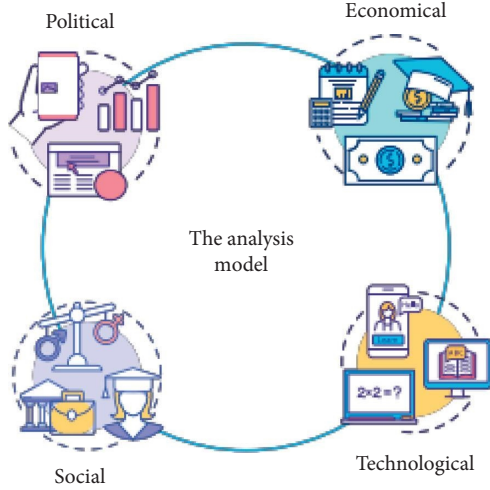


FIGURE 1: Education informatization development model.

proportion of tuition fees in middle-income families have always been far ahead of all types of universities [6]. Third is the society. Private universities use tuition discounts to collect tuition fees, so the increase in their social donation income is higher than that of tuition fees. That is to say, private universities mainly rely on social donation funds to maintain their normal operation. In addition, the government, higher education institutions, and private organizations also provide financial assistance to poor students, such as student loans, scholarships and grants, and tax subsidies. It can be said that in American universities, grants, student loans, and private universities have built a unique financial model: high tuition/high aid.

The theory of higher education cost sharing is developed on the basis of human capital theory and public goods theory [7]. First of all, the human capital theory gave birth to the concept of education cost. The value of the resources consumed in the production of education is education cost. Education cost includes social actual cost and indirect cost of education, and personal actual cost and indirect cost of education. Secondly, the human capital theory regards education as an investment with economic value, which can bring not only personal benefits, but also a wide range of social benefits. The level of personal and social returns brought by education has become a realistic measure for the cost sharing of national and social investment in education [8]. Beyond a certain scale, private higher education will show limited competitiveness and limited exclusivity in consumption, but private higher education can bring huge positive external effects. This positive externality is manifested in two aspects: the individual educatee and the national society. On the one hand, through receiving higher education, the individual educatee gains an increase in knowledge, ability, social status, and economic income; on the other hand, private higher education has made an important contribution to the popularization of higher education in China and the accumulation of human capital in the country. Moreover, private higher education has reduced the financial pressure

on the development of higher education in the country because of its self-financing investment mode. These funds can be used to develop basic education with higher social return. Therefore, we say that private higher education is a quasi-public product between public products and private products, and a public welfare undertaking that reflects the national interests [9]. Based on its public welfare and quasi-public product attributes, the supply of private higher education products should be shared by the government, market, and society.

3. Method

3.1. Theoretical Basis of Algorithm. The BP neural network algorithm includes two stages: forward presentation and backward presentation. The so-called forward propagation stage means that the sample data are calculated and processed by the hidden nodes in the input layer from top to bottom, and the output of the upper layer node is the input of the lower layer node and finally propagates to the output. The weights of all network edges remain unchanged during propagation. After the prediction error is calculated, it enters the back propagation stage; that is, the error is returned to the input node in the reverse direction layer by layer [10].

In BP neural network, the prediction error of output node j of the t -th iteration will be in the form of error square:

$$\begin{aligned} E_j(t) &= \frac{1}{2} \left(|e_j(t)| \right)^2 \\ &= \frac{1}{2} \left(|Y_j(t) - Y'_j(t)| \right)^2, \end{aligned} \quad (1)$$

where $e_j(t)$ is the prediction error, $Y_j(t)$ is the sample observation value of the output node, and $Y'_j(t)$ is the output value of the output node. If the adder and sigmoid activation function are substituted into the above formula:

$$Y'_j(t) = f(U_j^N(t)). \quad (2)$$

The sigmoid function of the t -th iteration is

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

$$U_j^N(t) = \sum_i W_{ij}^N(t) O_i^N(t) + \theta_j(t), \quad (4)$$

where $U_j^N(t)$ is the calculation result of the adder:

$$N = (1, 2, \dots, n). \quad (5)$$

W_{ij}^N is the weight of the network edge formed from the i -th hidden node of layer N to the j -th node of layer $n+1$, $O_i^N(t)$ is the output of the i -th hidden node of layer N , and $\theta_j(t)$ can be regarded as a constant term of linear combination [11]. The definition of the total prediction error at the output node of the t -th iteration is

$$\begin{aligned}
E(t) &= \frac{1}{2} \sum_j |e_j(t)|^2 \\
&= \frac{1}{2} \sum_{p=1}^p \sum_j (Y_{jp}(t) - Y'_{jp}(t))^2,
\end{aligned} \tag{6}$$

where p is the number of samples. It can be seen that the t -th iteration error is a multivariate nonlinear function of the weights of network edges, the values of input variables and output values.

The purpose of weight adjustment in the network is to reduce the overall demand. Therefore, the t -th iteration must follow the direction in which the error plane descends the fastest, i.e., the direction of the negative gradient [12]. The network weight adjustment amount of the i -th node of layer N and the j -th output node of layer $N + 1$ is shown in formula 7 and formula 8 according to the differential chain rule:

$$\begin{aligned}
\Delta W_{ij}^n(t) &= -\eta \frac{\partial E(t)}{\partial W_{ij}^n(t)} \\
&= -\eta \frac{\partial E(t)}{\partial e_j(t)} * \frac{\partial e_j(t)}{\partial Y'(t)} * \frac{\partial Y'(t)}{\partial U_j^n(t)} * \frac{\partial U_j^n(t)}{\partial W_{ij}^n(t)},
\end{aligned} \tag{7}$$

$$\Delta W_{ij}^n(t) = -\eta e_j(t) (-1) f'(U_j^n(t)) O_i^n(t), \tag{8}$$

where η is the learning rate and the negative sign indicates the negative gradient direction. Since sigmoid activation function is adopted, as shown in formula:

$$f'(U_j^n(t)) = f(U_j^n(t)) * (1 - f(U_j^n(t))). \tag{9}$$

Therefore, as shown in formula:

$$\Delta W_{ij}^n(t) = \eta e_j(t) * f'(U_j^n(t)) (1 - f(U_j^n(t))) * O_i^n(t). \tag{10}$$

Make it as

$$\delta_j^n(t) = e_j(t) * f(U_j^n(t)) (1 - f(U_j^n(t))). \tag{11}$$

The above formula is called the local gradient of node j :

$$\Delta W_{ij}^n(t) = \eta \delta_j^n(t) * O_i^n(t). \tag{12}$$

Therefore, the network weight adjustment of point j during $t + 1$ iteration is

$$W_{ij}^n(t + 1) = (\alpha W_{ij}^n(t) + \eta \delta_j^n(t)) * O_i^n(t). \tag{13}$$

Through calculation, the local gradient of the j -th node of the N ($N = 1, 2, \dots, n, n + 1$) hidden layer is

$$\begin{aligned}
\delta_j^N(t) &= \frac{\partial E_j(t)}{\partial f(U_j^N(t))} \\
&= \frac{\partial E_j(t)}{\partial f(O_j^N(t))} * \frac{\partial f(O_j^N(t))}{\partial f(U_j^N(t))},
\end{aligned} \tag{14}$$

$$\delta_j^N(t) = f'(O_j^N(t)) \sum_{i=1}^i \delta_i^{N+1}(t) W_{ij}^{N+1}(t). \tag{15}$$

In the calculation process, the network weights are adjusted according to (15) until all hidden layers are covered and all network weights are adjusted.

3.2. Determination of Network Structure. The complexity of the neural network is determined by the number of original layers and the number of hidden units in each layer [13]. Theoretically, although multi-layer networks can obtain more accurate analysis results, experiments show that, unless the actual problem requires, using networks with more than two hidden layers will make the problem solving more complex, and sometimes networks with multiple hidden layers are more difficult to obtain effective solutions. Therefore, it is most cost-effective to choose a network with a hidden layer [14]. There is no authoritative criterion for determining the number of hidden nodes. Usually, the more complex the problem is, the more hidden nodes are required. To solve this problem, we can first give a rough network structure and then gradually adjust it in the process of model training. Network structure is very important for neural network model. At the initial stage of model establishment, the empirical value method is adopted. First, the hidden layer is set as one layer. The default number of hidden nodes is as shown in formula:

$$\max\left(3, \frac{(n_i + n_j)}{20}\right), \tag{16}$$

where n_i, n_o , respectively, represent the number of input nodes and the number of output nodes [15]. The input node is 5, and the output node is 1, so the number of hidden nodes of the hidden layer is calculated

$$\max\left(3, \frac{(5 + 1)}{20}\right) = 3. \tag{17}$$

In the initial network selection, a hidden layer is selected, and three hidden nodes are determined as the initial model. The weight adjustment from hidden layer to input layer is

$$\delta_{kp}^1(t) = f'(O_{kp}(t)) \sum_{p=1}^{45} \sum_{j=1}^1 \delta_{jp}^2(t) W_{kj}^2, \quad (18)$$

$\delta_{kp}^1(t)$ is the local gradient of the hidden layer, as shown in

$$\Delta W_{ik}^1(t) = \eta \delta_{kp}^1(t) X_{kp}(t), \quad (19)$$

$$W_{ik}^1(t+1) = \alpha W_{ik}^1(t) + W_{ik}^1(t). \quad (20)$$

The iteration shall be carried out according to the above iteration method until the iteration cycle is 250 times.

Suppose the input layer of the BP network has n nodes, the hidden layer has q nodes, the output layer has m nodes, the weight between the input layer and the hidden layer is v_{ki} , the weight between the hidden layer and the output layer is w_j , and the output of the hidden layer node is z_k , as shown in Figure 2.

By comparing the results of the multiple regression model, it can be seen that the maximum error of the regression analysis results based on 6 influencing factors is 4321, the minimum error is 8, and the average error is less than 2164.5, the maximum error of the regression analysis results based on 3 principal components is 3529, the minimum error is 40, and the average error is less than 1734.5, while the maximum error of the BP neural network model based on 6 influencing factors is nearly 2500, the minimum error is about 500, and the average error is 1500, indicating that the BP neural network method is more suitable for college tuition. At the same time, it is found that the number of influencing factors has an impact on the prediction effect of the network.

It can be seen from the above prediction results and error effect diagrams that the BP neural network method based on 6 major factors has better prediction effect than the regression analysis method based on 6 major factors and 3 major factors, indicating that BP neural network is used in college tuition pricing. The specific results are shown in Table 1.

The average impact value (MIV—mean impact value) method is used to find the input items that have a greater impact on the results, and then the neural network is used to filter variables. MIV is considered to be one of the best indicators for evaluating the correlation of variables in neural networks, and it also opens up new ideas for solving such problems. The specific calculation process of MIV variable screening implementation: after the network training is over, add or subtract 10% of each independent variable in the training sample P on the basis of the original value to form the training samples P1 and P2, use P1 and P2 as simulation samples, respectively, use the established network to simulate, get two simulation results A1 and A2, and find the difference between A1 and A2—the change value of the output after changing the independent variable (IV, impact value), and IIV. According to the number of observed cases, the average influence value (MIV) of the independent variable on the dependent variable—network output—is obtained. Calculate the MIV value of each independent variable one by one according to the above method. Finally, according to the absolute value of MIV, the

independent variables are sorted, and the importance of the influence of the independent variables on the output is sorted, so as to determine the degree of influence of the input on the prediction effect, that is, to achieve filtering of variables. The specific process of the MIV variable screening method is shown in Figure 3.

4. Results and Analysis

For the research on the current situation of cost control, this section takes Y University as an example.

The school's income includes financial appropriation income, business income, income turned over by affiliated units, and other income [16]. The financial appropriation income is on the rise, and its proportion is also increasing year by year. By 2021, the financial appropriation income will be 862.8736 million yuan, accounting for 65.69% of the total income of the university. This shows that the Ministry of Education has given greater financial support to Y University and shows that the country is paying more for vocational training. More funding is needed to increase school efficiency and support school improvement. The overall amount of business income is on the rise, but its proportion is decreasing. This is mainly because the school's financial allocation income has increased significantly, and its proportion is increasing year by year [17] as shown in Figure 4.

It can be seen from the above figure that the total income of Y University has shown an upward trend from 2012 to 2021. Among them, the larger increase in 2012 was due to the higher financial appropriation income in this year [18]. Other income mainly includes interest income, non-equivalent financial appropriation income, and appropriation income from other departments. In 2012 and 2014, the income handed over by affiliated units mainly came from the income handed over by a hotel in Y University, which will not be handed over after 2015.

4.1. Overview of Tuition Status in the past 10 Years. With the development of education, the scale of Y University is expanding, and the cost of education is also increasing correspondingly. Over the past 10 years, the total cost of school education has shown a fluctuating growth. In 2012, the total cost of school education was 569 million yuan. In 2021, the total cost of school education reached 1308178000 yuan, an increase of 2.3 times. At the same time, it can be seen that the school education cost increased significantly in 2012, mainly because the school had more other capital expenditures in 2012, and the average student expenditure also showed an increasing trend as a whole. However, the cost increases too fast, and it is easy to have a shortage of funds, which further increases the difficulty of the school's financial cost management. Therefore, it is necessary to study the education cost of Y University, so as to control its expenditure and improve the efficiency of the use of capital resources. However, the overall trend of education cost is consistent with the law of income, which reflects the principle of determining expenditure by income and

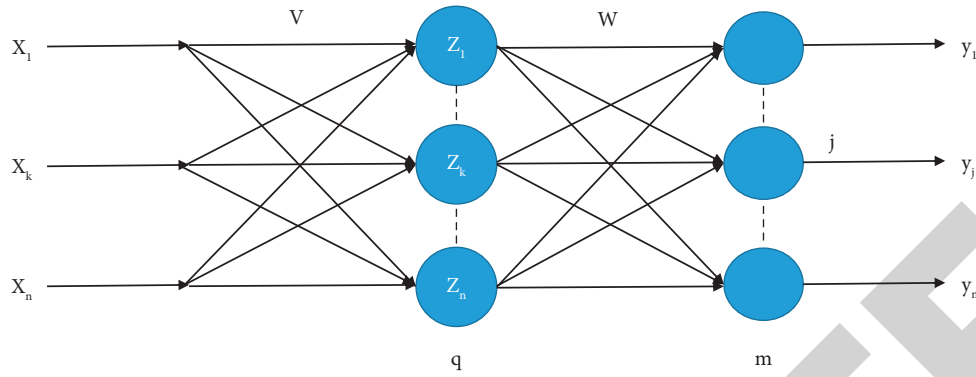


FIGURE 2: Topological structure of three-layer neural network.

TABLE 1: 6-factor and 3-factor regression analysis and 6-factor BP neural network error comparison.

Error	6-factor BP neural network	6-factor regression analysis	3-factor regression analysis
Influencing factors	X1 X2 X3 X4 Xn	X1 X2 X3 X4 X5 Xn	X1 X2 X3
Maximum error	2500	4321	3529
Minimum error	500	8	40
Average error	1500	2164.5	1734.5

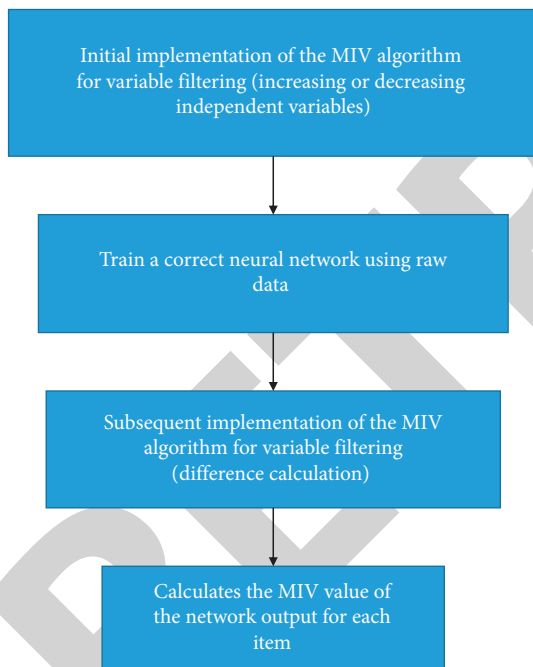


FIGURE 3: Flowchart of variable screening based on BP neural network.

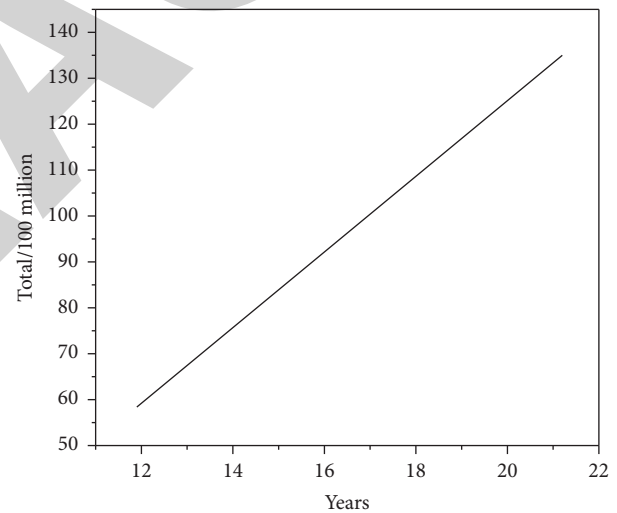


FIGURE 4: Income statistical histogram in recent 10 years.

balancing revenue and expenditure [19]. The cost classification of Y University education includes six aspects: wage and welfare expenditure, commodity service expenditure, subsidies to individuals and families, subsidies to enterprises and institutions, debt interest expenditure, and other capital expenditure [20].

The larger part is the wage and welfare expenditure and the commodity and service expenditure, the proportion of which changes in the range of 20%–40% [21]. Among them, the wage and welfare expenditure showed an upward trend

over time, from 141721300 yuan in 2012 to 523612500 yuan in 2021, and the proportion also maintained an increasing trend, from 24.91% in 2012 to 40.03% in 2021, an increase of 15 percentage points. And in recent 10 years, the overall trend is downward. The decrease of debt interest expenditure year by year shows that the loan amount of Y University is decreasing, and the debt risk it faces is also relatively reduced. Among the average total expenditures of general institutions of higher learning under the central ministries and commissions, the expenditure on wages and welfare accounted for 26.13%, the expenditure on subsidies to individuals and families accounted for 23.85%, the expenditure on goods and services accounted for 26.42%, other capital expenditures accounted for 15.35%, and the expenditure on capital construction accounted for 8.25%. In 2015, the wage and welfare expenditure of Y University was

slightly lower than the overall level of China. Compared with the average level of China, the subsidy to individuals and families was significantly lower, but the expenditure on goods and services was much higher than the average level of China [22].

4.2. Detailed Analysis of Education Cost in Recent 10 Years.

Y University wages and health benefits include base wages, allowances, other health services, wages and other wages, and medical expenses.

The total wages and benefits have shown an overall growth trend in the past 10 years, from 142 million yuan in 2012 to 524 million yuan in 2021, an increase of nearly 2.7 times. From 2016 to 2021, the number of teaching staff was 3200, but the per capita salary and welfare increased from 117300 yuan in 2016 to 163600 yuan in 2021, with a growth rate of 39.47%. It can be seen that Y University pays more and more attention to its teaching staff. Among them, performance salary and other salary and welfare expenses account for a large proportion in the whole salary and welfare expenses, with a total proportion of more than 70%, or even high. The level of performance pay is related to the educational background, length of service, professional title, position, and other factors of the teaching staff. The implementation of performance pay can mobilize the enthusiasm of the teaching staff, promote the development of the school cause, improve the teaching quality, improve the level of running a school, and achieve innovative development. Other salary and welfare expenses mainly refer to the salary expenses of the nonenterprise teaching staff of the school. Before 2020, other social security refers to medical insurance, work injury insurance, maternity insurance, and endowment insurance for faculty members with career titles. After 2020, the endowment insurance for noncareer faculty members will also be included. Therefore, other social security will increase significantly in 2020 [23]. The subsidies to individuals and families include retirement fees, housing provident fund, financial aid, and other subsidies to individuals and families.

The proportion of retirement expenses in the whole subsidy expenditure for individuals and families is not large, and the overall proportion shows a downward trend. The two subjects with the largest proportion are retirement expenses and financial aid, with a total proportion of more than 60%. Among them, the scholarships granted by Y University to students are included in the financial aid subject for accounting. In addition to the national scholarships such as “national scholarships, national inspirational scholarships, home-based student loans, and national financial aid,” the university also has a student reward and funding system such as “school scholarships, on campus subsidies, and on campus work study posts.” Each doctoral student receives an annual subsidy of 8000 yuan, and each master graduate student receives an annual subsidy of 2000 yuan. The absolute value of the housing provident fund is increasing year by year, accounting for more than 10%, with little fluctuation. In 2021, the amount of the housing provident fund in the individual and family subsidies is 0

because Y University put the housing provident fund into the salary and welfare expenditure for accounting in 2021.

Y University’s subsidy to enterprises and institutions only includes one item, namely, the subsidy to public institutions, which is the subsidy to the three independent colleges under Y University for the education and teaching work of independent colleges as shown in Table 2.

Debt interest includes both Chinese debt interest payment and American debt interest payment. During the nine years from 2012 to 2021, Y University only paid interest on Chinese debt. In 2021, both Chinese debt interest payment and American debt interest payment came from a Japanese yen loan project of Y University in 2021.

According to the data of recent 10 years, the debt interest expenditure of Y University shows a downward trend as a whole. The average student debt interest payment decreased from 1500 yuan in 2013 to 0300 yuan in 2021. The gradual optimization of this debt environment is conducive to the normal operation of Y University’s teaching and scientific research.

4.3. Analysis on the Influencing Factors of Education Cost.

Considering the cost economy of the research method itself, and referring to the idea of equivalence in cost accounting, according to the financial budget rules of Y University, the number of master’s students is converted into the number of undergraduates at the ratio of 2.0, the number of doctoral students into the number of undergraduates at the ratio of 3.0, and the number of remaining students into the number of undergraduates at the ratio of 3.0. In addition, as LR college is an independent college under Y University, Y University will provide it with exclusive subsidies every year. Therefore, the number of students in LR college is not included in the total number of students and is accounted for independently.

The professors of the university are converted into general lecturers at the ratio of 2.0, and the associate professors are converted into general lecturers at the ratio of 1.5 to confirm the resource drivers and allocate resources, so as to ensure the rationality of accounting.

The school equipment includes teaching multimedia equipment, large-scale experimental equipment, etc. The equipment of Y University worth more than 200000 yuan is selected as the basis for accounting, as shown in Table 3.

The equation of multiple linear regression model is usually expressed as

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_j X_j + \dots + \beta_k X_k + \mu, \quad (21)$$

where k represents the number of explanatory variables.

$$\beta_j (j = 1, 2, L, k). \quad (22)$$

The above formula is the coefficient, and μ is the random error. After the sample data are substituted into the regression analysis, the judgment shall be made according to the output results. By summarizing the research cost of relevant literature and according to the previous analysis, the

TABLE 2: Details of subsidies to enterprises and institutions from 2012 to 2021.

Project	Subsidies for public institutions	Total
2012	5545.32	5545.32
2013	4595.39	4595.39
2014	3365.94	3365.94
2015	3679.68	3679.68
2016	3997.23	3997.23
2017	3740.12	3740.12
2018	4454.54	4454.54
2019	4936.23	4936.23
2020	6515.94	6515.94
2021	—	—

TABLE 3: Statistics of important equipment quantity.

Particular year	Equipment quantity (set)
2012	119
2013	121
2014	142
2015	175
2016	175
2017	192
2018	218
2019	223
2020	238
2021	251

educational cost of Y University is selected as the explanatory variable and expressed by y . The number of students (ST), number of faculty (TE), power consumption (M), water consumption (M'), floor area (S), building area (S'), number of students (LR), and number of important equipment (EQU) are selected as explanatory variables. See Table 4 for details.

Combined with the analysis of the influencing factors of education cost and the introduction of the above models, the following regression model of education cost prediction is established for empirical test:

$$Y = \beta_0 + \beta_1 ST + \beta_2 TE + \beta_3 M + \beta_4 M' + \beta_5 S + \beta_5 S' + \beta_7 LR + \beta_8 EQU + \mu. \quad (23)$$

The software SPSS.22 is used to make descriptive statistics on all variables, and the results are shown in Table 5.

From the perspective of dependent variables, the minimum value of education cost y is 567.812 million yuan, and the maximum value is 1308.1781 million yuan. According to the original data, it is found that the time point corresponding to 567.812 million yuan is 2010, and the time point corresponding to the maximum value is 2021. In general, the education cost of Y University is on the rise. From the perspective of independent variables, in the past 10 years, except for the general trend of the number of students in LR college, the overall trend of other independent variables is in the state of growth, which is consistent with the requirements of Y University to continuously expand the scale and improve the quality of running schools in recent years.

Input the data into the software SPSS.22, use the linear regression function in the analysis to process the sample

TABLE 4: Definition of variables.

Variable properties	Variable symbol	Variable interpretation
Explained variable	Y	Education cost
Explanatory variable	ST	Number of students
Explanatory variable	TE	Number of faculty
Explanatory variable	M	Electricity consumption
Explanatory variable	M'	Water consumption
Explanatory variable	S	Area covered
Explanatory variable	S'	Built-up area
Explanatory variable	LR	Number of LR students
Explanatory variable	EQU	Number of important equipment

data, and study the correlation between Y and eight independent variables. First, check the decisive coefficient of the model to judge the fitting degree. The R-square is 0.993, and the adjusted R-square is 0.935, so the fitting degree of the model is good, which can completely reflect the relationship between the data as shown in Table 6.

Secondly, when doing linear regression analysis, we can analyze the significance of the model according to the obtained ANOVA value and then judge the effectiveness of the overall model. The significance level of the whole model is 0.001, which indicates that the overall effectiveness and reliability of the model are high, and further analysis can be carried out as shown in Table 7.

It can be seen from Table 8 that among the eight selected explanatory variables, only the number of students, the number of faculty, water and electricity consumption, the number of students in LR college, and the number of important equipment have reached a significant level, and the relationship between the floor area and the building area and the education cost is not significant as shown in Table 8.

Since the relationship between the variables represented by the floor area (S) and the building area (S') and the education cost is not significant, they will be eliminated in the subsequent analysis to ensure the reliability of the regression results, and then the regression analysis will continue using the software SPSS.22. The output results are shown in Table 9, Table 10 and Table 11.

Combining the above, we can get the result of the final design-level equation. The different coefficients of the equilibrium regression are all positive, indicating that the total cost of training will further increase with the increase in the number of teachers and students. Parameter symbols have significant operational value.

The cost control system of colleges and universities is a unified whole, which includes subsystems such as cost organization, decision-making, implementation, information, and performance evaluation. If a university wants to implement effective education cost control, it should first establish an organizational system of the cost control system; that is, under the guidance of university leaders, it should establish a vertical cross-responsibility center with each functional department as the horizontal and each department and individual as the vertical. Each responsibility center shall prepare performance reports

TABLE 5: Descriptive statistics of variables.

Variable	N	Minimum value	Maximum	Mean value	Standard deviation
Y	10	56,781.20	130,817.81	96,111.94	29,275.54
ST	10	28,431.00	41,682.00	32,884.10	4,274.27
TE	10	2,940.50	4,001.50	3,625.60	330.56
M	10	20,233,846.15	39,523,653.85	31,848,942.31	6,322,808.69
M'	10	1,426,000.00	3,759,480.00	2,616,276.00	741,194.13
S	10	4,000.00	5,600.00	4,320.00	674.62
S'	10	890,000.00	1,060,000.00	996,000.00	62,218.25
LR	10	6,756.00	15,837.00	12,585.60	3,269.40
EQU	10	119.00	251.00	185.60	47.43

TABLE 6: Model summary.

Model	R	R ²	Adjust R ²	Standard estimation error
1	0.996 ^a	0.993	0.935	7,217.56

TABLE 7: Significance test of overall linearity (ANOVA^b).

	Sum of squares	df	Mean square	F	Sig (b)
Regression	7,143,459,915.51	8	892,932,489.44	27.141	0.001
Residual	52,093,229.66	1	52,093,229.66		
Total	7,195,553,145.17	9			

TABLE 8: Multiple regression coefficients of each variable.

Variable	Denormalization coefficient		Standardization coefficient		T	Significance
	B	Standard error	Bata			
Constant	-278,835.736	477,978.603			-1.583	0.008
ST	15.031	9.924	2.272		2.515	0.037
TE	-170.857	130.412	-1.997		-2.310	0.042
M	0.006	0.004	1.421		2.446	0.038
M'	0.026	0.026	0.674		1.981	0.041
S	-5.206	28.380	-0.124		-1.183	0.885
S'	-0.045	0.219	-0.099		-1.206	0.871
LR	16.921	9.618	1.956		2.759	0.033
EQU	458.259	768.972	0.769		1.596	0.045

TABLE 9: Model summary.

Model	R	R ²	Adjust R ²	Standard estimation error
1	0.996 ^a	0.992	0.977	4,257.061,81

TABLE 10: Significance test of overall linearity (ANOVA^b).

	Sum of squares	df	Mean square	F	Sig
Regression	7,141,185,419.490	6	1,190,197,569.915	65.675	0.001
Residual	54,367,725.684	3	18,122,575.228		
Total	7,195,553,145.174	9			

on schedule according to the work results, find out the gap between the actual cost amount and the budget amount, then analyze why such differences occur and timely report to the superior department to find out the problems existing in the work, take effective solutions, and implement management according to the specification requirements. Secondly, from the aspect of power,

we should set up the mutual checks and balances of the corporate governance structure of colleges and universities; that is, we should not only clarify the powers and responsibilities of the president, vice presidents, and the directors of various functional departments, but also let them check and balance each other, so as to promote their mutual restriction and cooperation at the same time, so as

TABLE 11: Multiple linear regression coefficients of each variable.

Variable	Denormalization coefficient		Standardization coefficient		T	Significance
	B	Standard error	Bata			
Constant	-360,666.718	146,650.206			-2.459	0.001
ST	14.020	4.120	2.119		3.403	0.042
TE	-156.666	40.113	-1.832		-3.9060	0.030
M	0.006	0.002	1.313		3.704	0.034
M'	0.021	0.010	0.595		2.274	0.045
LR	17.052	5.595	1.972		3.046	0.047
EQU	551.595	261.381	0.930		2.122	0.049

to promote the scientific and effective management of colleges and universities.

At present, although the cost accounting system of colleges and universities in China has made some achievements, its overall development is still in the exploration period. Therefore, only by continuously reforming and innovating the accounting system in colleges and universities can we meet the requirements of the "supervision and examination measures for the cost of higher education and training (Trial)." Only in this way can we apply more efficient procedures and lay a solid foundation for the calculation of college tuition fees. In addition, "higher schools" can combine management appropriately and competently, establish a financial accounting system according to the actual situation of colleges and universities, improve financial management functions, and integrate cost accounting principles with cost management to achieve process consistency. Establish a set of cost accounting system that meets both the accounting system and the development needs of the times.

University expenditure can be divided into capital expenditure and income expenditure. Capital expenditure means that the expenditure incurred can be allocated to multiple accounting periods. Income expenditure refers to the income obtained through this expenditure only related to the current accounting year. In the process of accounting, capital expenditure is first included in the asset account and then transferred to the appropriate expense account by stages according to the income. Income expenditure is directly included in the relevant cost items of the current year. Only by correctly distinguishing between capital expenditure and income expenditure, can we reasonably determine which expenditure should be directly included in the current period and accounted in the cost of colleges and universities, and which expenditure should be accounted in the cost of colleges and universities after amortization.

When each cost occurs, the relevant supervision and Audit Department of the University shall specify the specific purpose of each cost and strictly trace some nonconforming or nonspecific expenses with large amount, so as to resolutely put an end to waste. Some avoidable nonessential expenditures should be strictly controlled. Those that need to be simplified should be simplified as much as possible. Before relevant equipment and tools are scrapped, they must think twice and carefully, and those that can be reused must be reused; take the plan as the guide, make careful arrangements, make full use of modern information means, set

up and refine accounting subjects, calculate costs reasonably and accurately, and achieve the purpose of cost control under the premise of following the existing "accounting system of colleges and universities" and "financial system of colleges and universities."

Employees spend a significant portion of the cost of college. The human cost of Y University accounts for about 50% of the total tuition fee. Therefore, we need to pay attention to adhering to higher education management. The value of managing human resources can be accomplished through two factors: one is to make it easier for employees to teach; the other is to improve employee job performance. Achieving cost savings and improving employee performance are important for colleges and universities. This requires colleges and universities to implement measures to reform the personnel system, solve the problems of over-staffed personnel and unclear responsibilities between departments within colleges and universities, and try to ensure the rationalization of the proportion among students, teachers, administrative personnel, and logistics support personnel. An important link in the reform of the personnel system is to implement the appointment system and follow the principle of "three determinations" (department, position, and staffing).

The two measures of department simplification and staffing compression are to improve the team structure, reduce personnel, improve efficiency, and promote the development of colleges and universities. Streamlining departments and reducing headcount can improve efficiency, but in the specific implementation process, it should be analyzed according to specific conditions, and different personnel should adopt different streamlining methods. China's higher education is in the stage of rapid development. Due to the rapid increase in the number of college students, the number of teachers according to the existing best teacher-student ratio may be more than the existing number. Therefore, we should proceed from reality and take corresponding measures according to the specific problems faced by colleges and universities. For the staff other than university teachers, the university should try its best to streamline, reduce the redundant staff, improve the work efficiency of the remaining staff, and eliminate unnecessary personnel expenditure.

Encouraging the rational flow of university staff can enable teachers to give full play to their expertise, form a dynamic and vibrant management system for the teaching staff, and constantly promote the optimization and

upgrading of the teaching staff. Redundant personnel after downsizing shall be properly resettled through job transfer and diversion, and efforts shall be made to create an employment environment so that they can give full play to their talents. For administrative personnel and logistics staff, the method of “one person with multiple posts and one post with multiple duties” should be implemented. By configuring the best educational resources, the quality of college assets and human resources can be incorporated into the overall game, and the benefits of colleges and universities can be improved.

5. Conclusion

This paper uses a variety of regression models to explore the impact of Y University’s tuition on the number of students, teachers, and resource use, and develops multiple loops to study its impact on the tuition of Y University. The impact of the tuition fee of Y University on students, teachers, water and electricity consumption, equipment, and so on is determined. Therefore, Y University should pay attention to the consumption of human resources, material resources, and energy, establish relevant systems in time, ensure the optimal allocation of resources, and promote the development of the university.

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 author declares that there are no conflicts of interest.

Acknowledgments

This work was supported by the Chengdu Technological University.

References

- [1] B. Hassan, S. Makkieh, and N. Titizian, “Forecasting the final cost of infrastructure projects in Syria using earned value management and artificial intelligence,” *Tishreen University Journal for Research and Scientific Studies*, vol. 42, no. 1, pp. 197–2018, 2020.
- [2] S. R. Nazmul and R. Sanjoy, “Conventional and current way of interpretation and cost forecasting,” *Journal La Bisecoman*, vol. 1, no. 6, pp. 30–33, 2020.
- [3] J. L. Zweier, A. Samouilov, and D. A. Komarov, “Evaluation of fast scan epr for high-resolution imaging using nitroxide radical probes at 1.2ghz,” *Applied Magnetic Resonance*, vol. 53, no. 1, pp. 233–246, 2021.
- [4] K. J. Kim, S. R. Kim, J. Lee, J. Y. Moon, S. H. Lee, and S. J. Shin, “Virtual conference participant’s perceptions of its effectiveness and future projections,” *BMC Medical Education*, vol. 22, no. 1, pp. 10–17, 2022.
- [5] V. T. Pham and B. Tran-Nam, “Estimating unit cost of public university education in vietnam,” *Educational Research for Policy and Practice*, vol. 20, no. 3, pp. 279–305, 2020.
- [6] M. Abdel-Sattar, R. S. Al-Obeed, A. M. Aboukarima, and D. H. Eshra, “Development of an artificial neural network as a tool for predicting the chemical attributes of fresh peach fruits,” *PLoS One*, vol. 16, no. 7, Article ID e0251185, 2021.
- [7] K. Ea and R. Sk, “Analysis of artificial neural networks training models for airfare price prediction,” *Artificial Intelligence*, vol. 25, no. 3, pp. 45–50, 2020.
- [8] D. Yue, Y. He, and Y. Li, “Piston error measurement for segmented telescopes with an artificial neural network,” *Sensors*, vol. 21, no. 10, 3364 pages, 2021.
- [9] F. B. Gencer, X. Xhafa, B. B. Inam, and M. B. Yelten, “Design and validation of an artificial neural network based on analog circuits,” *Analog Integrated Circuits and Signal Processing*, vol. 106, no. 3, pp. 475–483, 2021.
- [10] A. R. Kang, J. Lee, W. Jung et al., “Development of a prediction model for hypotension after induction of anesthesia using machine learning,” *PLoS One*, vol. 15, no. 4, Article ID e0231172, 2020.
- [11] W. S. Kim, D. H. Lee, Y. J. Kim, Y. S. Kim, and S. U. Park, “Estimation of axle torque for an agricultural tractor using an artificial neural network,” *Sensors*, vol. 21, no. 6, 1989 pages, 2021.
- [12] Y. Li, M. Yang, Z. Liu et al., “Detection and diagnosis of myocarditis in young patients using ecg analysis based on artificial neural networks,” *Computing*, vol. 102, no. 1, pp. 1–18, 2020.
- [13] J. Liu, M. Zhao, G. Li, and J. Chen, “Multiple Linear Regression Prediction and Wavelet Neural Network Based Intelligent Online Tuning Control Method,” *IEEE Access*, vol. 8, no. 99, p. 1, 2020.
- [14] Q. Kong, G. Jiang, Y. Liu, and J. Sun, “Location of the leakage from a simulated water-cooling wall tube based on acoustic method and an artificial neural network,” *IEEE Transactions on Instrumentation and Measurement*, vol. 70, no. 99, pp. 1–18, 2021.
- [15] N. N. A. M. Et al, “Analysis on students’ learning habits: identifying the contributory factors of learning during the covid-19 pandemic using radial basis function (rbf),” *Turkish Journal of Computer and Mathematics Education (TURCO-MAT)*, vol. 12, no. 5, pp. 1736–1743, 2021.
- [16] Q. Zhu, A. Gu, D. Li, T. Zhang, L. Xiang, and M. He, “Online recognition of drainage type based on uv-vis spectra and derivative neural network algorithm,” *Frontiers of Environmental Science & Engineering*, vol. 15, no. 6, pp. 136–139, 2021.
- [17] L. Guo, R. Man, Y. Wu, H. Lv, and H. Yu, “Anti-injury Function of Complex Spiking Neural Networks under Random Attack and its Mechanism Analysis,” *IEEE Access*, vol. 8, no. 99, p. 1, 2020.
- [18] M. Fan and A. Sharma, “Design and implementation of construction cost prediction model based on svm and lssvm in industries 4.0,” *International Journal of Intelligent Computing and Cybernetics*, vol. 14, no. 2, pp. 145–157, 2021.
- [19] M. S. Pradeep Raj, P. Manimegalai, P. Ajay, and J. Amose, “Lipid data acquisition for devices treatment of coronary diseases health stuff on the internet of medical things,” *Journal of Physics: Conference Series*, no. 1, Article ID 012038, 2021.
- [20] X. Liu, C. Ma, and C. Yang, “Power station flue gas desulfurization system based on automatic online monitoring platform,” *Journal of Digital Information Management*, vol. 13, no. 06, pp. 480–488, 2015.

Retraction

Retracted: Adaptive Control Strategy of Multiemergency Power Supply Network System Connected to New Energy

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. Zhang, M. Zhong, M. A. Y. Sun, and Y. Wang, "Adaptive Control Strategy of Multiemergency Power Supply Network System Connected to New Energy," *Security and Communication Networks*, vol. 2022, Article ID 5733358, 11 pages, 2022.

Research Article

Adaptive Control Strategy of Multiemergency Power Supply Network System Connected to New Energy

Wei Zhang ^{1,2,3}, Ming Zhong,^{2,3} Minfu A,^{2,3} Yumei Sun,⁴ and Yang Wang⁴

¹Polytechnic Institute, Zhejiang University, Hangzhou, Zhejiang 310015, China

²Inner Mongolia Power Research Institute, Hohhot, Inner Mongolia 010020, China

³Inner Mongolia Enterprise Key Laboratory of Smart Grid Simulation of Electrical Power System, Hohhot, Inner Mongolia 010020, China

⁴Inner Mongolia Borelles Electric Power Engineering Design Co., Ltd., Hohhot, Inner Mongolia 010010, China

Correspondence should be addressed to Wei Zhang; 11810089@zju.edu.cn

Received 17 June 2022; Revised 2 August 2022; Accepted 27 August 2022; Published 15 September 2022

Academic Editor: Tao Cui

Copyright © 2022 Wei Zhang et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

In order to improve the adaptive control effect of the multiemergency power supply networking system connected to new energy (NE), this paper studies the adaptive control strategy (ACS) of the multiemergency power supply networking system connected to NE by combining intelligent algorithms and determines the appropriate installation node of the distributed power supply according to the voltage stability index. Moreover, this paper proposes a method to optimize the distribution network feeder reorganization and distributed power configuration problems based on the fireworks algorithm to reduce the network loss and improve the voltage distribution. In addition, distribution network reorganization and distributed power configuration optimization can more effectively minimize network losses and improve voltage distribution. Through the experimental research, it can be seen that the ACS of the multiemergency power supply network system connected to NE proposed in this paper has the established effect.

1. Introduction

As the common carrier of power transmission and power market, the power grid is the basic platform and main medium to ensure the development of NE [1]. Therefore, regional power grids are an inherent requirement and an inevitable choice to transform the energy structure and power development mode and achieve sustainable development [2] such as uncoordinated planning and construction, lack of management of power generation and grid-connected operation, inadequate technical standards, approval of supporting grid projects, and approval and construction lag to accurately and deeply recognize these problems [3]. Under such a background, it is urgent to build a comprehensive evaluation index system and corresponding evaluation methods that can reflect the coordinated development (CD) of NE and regional power grids, so as to enhance the identification of the degree of development

coordination between the two. The results of the study found the key influencing factors of the CD, and provided a reference for the relevant departments to formulate the promotion measures for the CD of the two [4]. In addition, there are still many problems in the current electricity market system, such as the competition mechanism only exists on the power generation side, and the electricity price mechanism cannot meet the market demand. This requires the establishment and improvement of a power supervision mechanism that adapts to the market structure to optimize power generation side management, power transmission and distribution management, and power sales side management [5]. Under the premise that the scale of NE power generation (NEPG) and grid connection is expanding, a comprehensive evaluation system and method for the development of NE and regional power grids should be constructed, and the problems existing in the power generation management end and power supply management

end should be found in time, which is conducive to the effective use of resources and energy. The optimal configuration in space can promote the power system to meet the various requirements of the market and the environment, and improve social welfare [6]. Since large-scale NEPG has been developed in recent years, its coordinated planning with regional power grids belongs to an emerging power development model. At present, there are relatively few studies on the coordination evaluation method of this model [7].

The literature [8] is based on AHP-distance. The coordination degree combination model conducts a comprehensive evaluation and research on the coordination degree of low-carbon power grid planning. Reference [9] analyzes the coordination degree between distribution network and power load from the aspects of reliability of power supply, equipment utilization, and characteristics of economic operation. Based on the analysis of the three aspects of safety, reliability, and economy, the literature [10] pointed out that photovoltaic power generation has an impact on the traditional power grid. Therefore, an index system reflecting the CD of photovoltaic power generation and power grid has been constructed. Combined with the connotation of CD, a set of comprehensive evaluation index system that can reflect the CD of NE and regional power grids is constructed by defining and analyzing the coordinated planning mode of NE sources and regional power grids. The corresponding weights are constructed from the comprehensive evaluation model [11] and using this model to evaluate the CD degree of NE and regional power grids in the whole country [12] and draw relevant conclusions, in order to provide decision-making reference for the coordinated planning of NE and regional power grids [13].

Power sources can be divided into traditional power sources and NE sources according to the type of energy. The power source formed by traditional power generation methods such as thermal power generation and hydropower generation is the traditional power source. According to the voltage level of the transmission line, the power grid can be divided into transmission network and distribution network [14]. The operation of the power system includes power generation, transmission and distribution, dispatching, and electricity consumption. Therefore, the CD of NE and regional power grids requires manpower from four links. Among them, the coordination of NEPG is the basic link that affects the coordination degree of the entire regional power grid, power transmission, and distribution includes transmission, distribution, and transmission. It is an important link of large-scale development [15]; dispatching is the control and monitoring link of the entire power system and the realization of intelligent dispatching of regional power grids is an important guarantee for effectively realizing the CD of NEPG and regional power grids. Electricity consumption is an important part of the entire power system. The friendly and interactive power consumption link is conducive to the entire power system to quickly grasp the dynamic changes of NEPG [16]. It is necessary to realize the CD of the power supply at the power generation end and the power grid at the transmission end in all aspects, so as to

achieve the goal of ultimately achieving the overall CD of the power supply and the power grid. It is necessary to comprehensively consider the evaluation indicators of the mutual coordination and development of the four subsystems, including power generation, transmission and distribution, dispatching, and power consumption [17].

When the small-capacity NE power source is connected to the unbalanced distribution network, if the short-circuit calculation is still based on the traditional symmetrical component method after improvement, the power components will be difficult to decouple under the conditions of positive, negative, and zero sequence, and the calculation result will have a big difference from the actual results, that is, the improved symmetrical component calculation method makes it difficult to perform fault calculation for the unbalanced distribution network with different types of NE power sources. Therefore, it is necessary to carry out research on new short-circuit calculation methods for different types of NE sources connected to unbalanced distribution networks.

The contribution of this paper is to analyze the ACS of multiple NE access multiemergency power supply networking systems such as island detection. In traditional research, only one of these methods is often considered as the optimization object, but this paper adopts both optimization methods. The power distribution system integrated with NE is optimized by means of this method, and simulation research is carried out according to different planning situations.

2. Grid Adaptive Control

2.1. Radial Islanding Detection in Distribution Network.

For the normal operation of the radial distribution network, the situation of ring network and island operation should be avoided. This paper starts from the following three aspects to ensure that the topological structure of the system after the feeder reorganization can meet all the loads connected to the system, and the distribution network operates radially [18]:

- (1) Detection procedures for ring networks and islands;
- (2) Breadth-first node number generation;
- (3) "Pseudoring network" processing based on tie switch.

Whether it is to detect the ring network or the island, it is necessary to form the adjacency matrix of the topology structure of the power distribution system, and the adjacency matrix form required for different researches is also different. This paper uses the node-node adjacency matrix, and the two adjacent nodes are set to 1, otherwise it is set to 0.

2.1.1. Ring Network Detection. It takes the upper triangular matrix of the adjacency matrix, the number of nonzero values of the upper triangular matrix is the number of branches of the network, and the value minus the number of network nodes plus 1 equals the number of rings in the network.

2.1.2. *Island Detection.* Island detection is to detect the connectivity of the system. According to the adjacency matrix of the network, all connected nodes are searched from the first node (usually a transformer station), and it is judged that these nodes form continuous branches, respectively. In this way, the row vector of the final result matrix represents the continuous branches in the network, and the column vector represents the node number contained in each branch. That is, if the system has no islands, the result matrix is in the form of $1 \times n$, where n is the number of network nodes.

For different networks, the node numbering forms in the network data are often not uniform, and it is obviously unrealistic to manually organize the system network node and branch data into a uniform format. The most important thing is that the topological structure of the network after the optimization of the feeder reorganization will change, so it is particularly important to intelligently optimize the numbering of any structure that appears in the feeder reorganization.

This paper adopts the form of breadth-first node numbering. Numbering nodes in this way can ensure that the network formed by the included nodes is radiative and avoids the appearance of ring networks and isolated islands.

We assume that the network structure is shown in Figure 1, and the breadth-first node numbering process is as follows:

Step 1: as shown in Figure 1, the node number in the circle is the initial node, the first node is the substation node, which is set to No. 1, and its child node is set to No. 2 (for example, the initial node No. 6 is changed to No. 2), and the rest of the node numbers remain unchanged for the time being and are still any previous values.

Step 2: the algorithm searches for the branch connected to branch 1. If the parent node of one of the branches is the child node of the new label of the previous branch, for example, the parent nodes of branch 2 and branch 3 are the child nodes of branch 1, node 2, the order of nodes 3 and 4 is in the order of the branch label from low to high, then the child nodes of branch 2 and branch 3 are renumbered as 3 and 4, respectively.

Step 3: the algorithm searches again for the branch connected to the new numbered node 3. Since there is no branch connected to it, the branch connected to the newly numbered node 4 is searched instead. Branch 4 and branch 7 are connected to this node, so the parent node of the branch 4 and the branch 7 is 4, and the child nodes are 5 and 6, respectively.

2.2. *“Pseudoring” Partition Based on Tie Switch.* This paper defines “pseudoring network” as a ring network composed of tie switches and branches as shown in Figure 2. Figure 2 is the structure diagram of the IEEE-33 node test system. The system has five tie switches, which can form a ring network Lp1-Lp5 according to the form in the figure. Moreover, the branches not included in the ring network do not participate

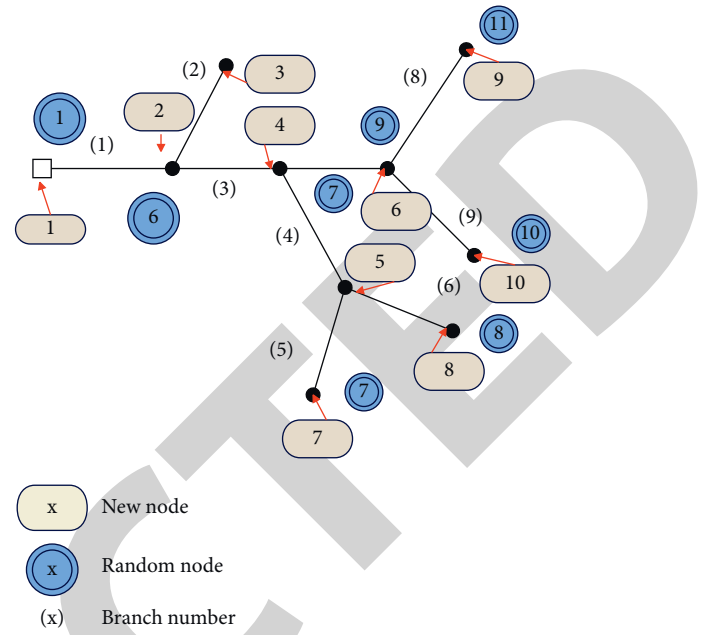


FIGURE 1: Example of node labeling.

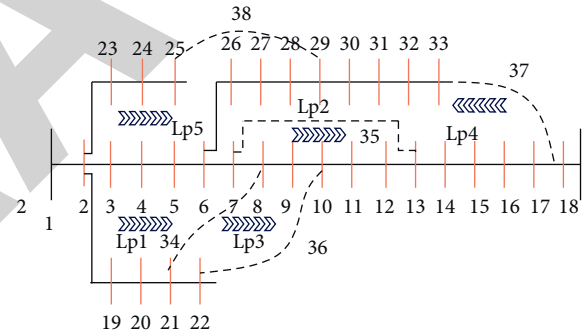


FIGURE 2: Pseudoring network topology of IEEE-33 node system.

in the process of feeder reorganization optimization. Because in a separate branch, if a segment switch is disconnected, an island node will inevitably be generated, so only the branch covered by the ring network is used as the range to be optimized. When the feeder is reorganized, only one switch in each loop can be opened.

The advantages of the ring network coding method are described below by taking a 33 node test system as an example. If the segment switch is considered a branch, there are a total of 37 branches in the system. According to the traditional optimization method, each optimized position (gene locus) is a 0/1 state quantity. In this method, the number of branches contained in each loop is 7, 10, 11, 7, and 16, respectively. It is easy to obtain them. The product of 86240, the computational burden is significantly reduced. In addition, compared with the traversal method, the use of this coding method itself can greatly reduce the possibility that the generated network topology structure contains ring network or island nodes. If combined with the ring network and island detection procedures, the generated topology can conform to the radial structure without islands.

2.3. Voltage Stability Index. The voltage stability index is used to “preset” the access nodes of the distributed power generation. Its functions are as follows:

- (1) The voltage distribution is one of the optimization goals of this chapter, and the voltage stability of each node is evaluated using the voltage stability index proposed in the literature. Moreover, nodes with lower stability indicators are more prone to voltage collapse.

Therefore, the voltage stability indicators of each node are calculated, and the indicators are arranged from low to high, and they are used as the optimal access nodes for distributed power sources. If there are three distributed power sources, the three nodes with the smallest voltage stability indicators are selected.

- (2) The location selection of access nodes, both of which are regarded as variables to be optimized in traditional methods. Before optimization, “presetting” the access node can effectively reduce the search space of the optimization algorithm.

Figure 3 is a schematic diagram of a simple power flow through the feeder. The problem is simplified as follows:

The impedance of the line is $R_k + jX_k$, the load between node k and node $k + 1$ is $P_{k+1} + jQ_{k+1}$, and the formula can be written from Figure 3:

$$I_k = \frac{V_k - V_{k+1}}{R_k + jX_k}, \quad (1)$$

$$P_{k+1} - jQ_{k+1} = V_{k+1} \cdot I_k. \quad (2)$$

Among them, k represents the branch number or starting node number, represents the current of branch k , V_k/V_{k+1} represents the voltage ratio between node k and node $k + 1$, and P_{k+1}/Q_{k+1} represents the active and reactive power transmitted from the feeder to node $k + 1$.

From formulas (1) and (2), we get

$$\begin{aligned} &|V_{k+1}| - \{|V_k| - 2P_{k+1}r_k - 2Q_{k+1}x_k\}|V_{k+1}|^2 \\ &+ \{P_{k+1}^2 + Q_{k+1}^2\}\{r_k^2 + x_k^2\} = 0. \end{aligned} \quad (3)$$

We assume the following:

$$\begin{aligned} b_k &= |V_k| - 2P_{k+1}r_k - 2Q_{k+1}x_k, \\ c_k &= \{P_{k+1}^2 + Q_{k+1}^2\}\{r_k^2 + x_k^2\}. \end{aligned} \quad (4)$$

Formula (3) is simplified to

$$|V_{k+1}| - b_k|V_{k+1}|^2 + c_k = 0. \quad (5)$$

From formula (5), it can be seen that the solution of $|V_{k+1}|$ has the following four cases:

- (1) $0.707[b_k - \{b_k^2 - 4c_k\}^{1/2}]^{1/2}$
- (2) $-0.707[b_k - \{b_k^2 - 4c_k\}^{1/2}]^{1/2}$
- (3) $-0.707[b_k + \{b_k^2 - 4c_k\}^{1/2}]^{1/2}$
- (4) $0.707[b_k + \{b_k^2 - 4c_k\}^{1/2}]^{1/2}$

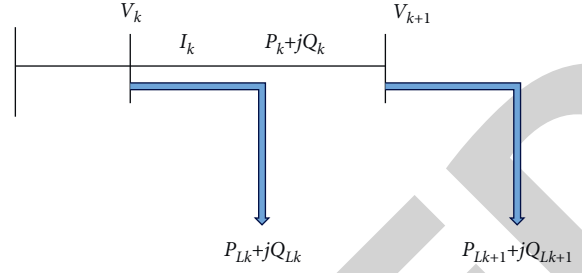


FIGURE 3: Schematic diagram of feeder.

According to the real data, P , Q , r , x , and V are generally expressed in the form of per-unit values, and b_k is usually positive. Since the ratio of $2P_{k+1}r_k + 2Q_{k+1}x_k$ and $|V_k|^2$ is usually small, the value of $4c_k$ is also small relative to b_k^2 , so $\{b_k^2 - 4c_k\}^{1/2}$ is approximately equal to b_k . Then, the values of the results (1) and (2) of $|V_{k+1}|$ are close to 0, which is not suitable, the value of the result (3) is negative, and the value of the result (4) is positive and practical. Therefore, the value of equation (5) is uniquely determined and its value is as follows:

$$|V_{k+1}| = 0.707 \left[b_k + \{b_k^2 - 4c_k\}^{1/2} \right]^{1/2}. \quad (6)$$

From formula (6), it can be seen that the conditions for the existence of the power flow calculation solution of the radial distribution system are as follows:

$$\begin{aligned} &b_k^2 - 4c_k \geq 0, \\ &\{|V_k|^2 - 2P_{k+1}r_k - 2Q_{k+1}x_k\}^2 + 4.0\{P_{k+1}^2 + Q_{k+1}^2\}\{r_k^2 + x_k^2\} \geq 0. \end{aligned} \quad (7)$$

After simplification,

$$\begin{aligned} &|V_k|^4 - 4.0\{P_{k+1}x_k - Q_{k+1}r_k\}^2 \\ &- 4.0\{P_{k+1}r_k + Q_{k+1}x_k\}|V_k|^2 \geq 0. \end{aligned} \quad (8)$$

We get

$$\begin{aligned} VSI_{k+1} &= |V_k|^4 - 4.0\{P_{k+1}x_k - Q_{k+1}r_k\}^2 \\ &- 4.0\{P_{k+1}r_k + Q_{k+1}x_k\}|V_k|^2. \end{aligned} \quad (9)$$

Among them, VSI_{k+1} is the voltage stability index of node $k + 1$. Its value represents the stability level of the radial distribution network. The fireworks algorithm is used to solve the problems of distribution network feeder reorganization and distributed power configuration.

As mentioned earlier, this paper uses voltage stability as the basis for which node the distributed power source is connected to, and the configuration capacity is determined by the optimization result of the fireworks algorithm.

2.4. Mathematical Model of Feeder Reorganization in Distribution Network

2.4.1. Optimization Objective

(1) *System Network Loss.* The mathematical model of power flow calculation will not be repeated in this chapter. The

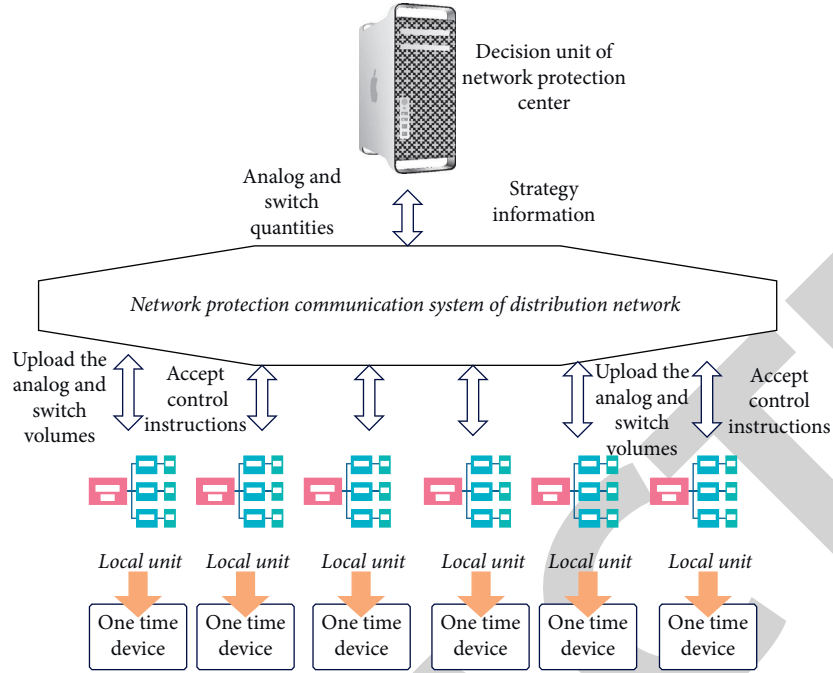


FIGURE 4: Schematic diagram of the networked protection system of the distribution network.

network loss of each branch of the distribution network is obtained through a power flow calculation as shown in the following formula.

$$P_{\text{Loss}}(k, k+1) = R_k \times \left(\frac{P_k^2 + Q_k^2}{|V_k|^2} \right), \quad (10)$$

$$P_{T,\text{Loss}} = \sum_{k=1}^{nb} P_{\text{Loss}}(k, k+1). \quad (11)$$

Among them, nb is the total number of branches of the system.

(2) *Voltage Offset Index*. A significant benefit that should be brought about by optimizing the network structure and distributed power configuration is that it can reduce the offset of the voltage of each node. The purpose of the voltage offset index is to prevent the capacity or layout of the distributed power supply from causing excessive voltage offset to the distribution system. The voltage offset index ΔV_D is defined as follows:

$$\Delta V_D = \max \left(\frac{V_1 - V_2}{V_1} \right). \quad (12)$$

Combining the above two points, the optimization objective function is as follows:

$$F = \min \left[\left(\frac{P_{T,\text{Loss}}^{op}}{P_{T,\text{Loss}}} + \Delta V_D \right) \right]. \quad (13)$$

Among them, $P_{T,\text{Loss}}^{op}$ is the optimized system network loss, and $P_{T,\text{Loss}}$ is the initial network loss of the system.

2.4.2. *Constraints*. (1) Power limitation:

$$P_{\text{sub}} = \sum_{k=2}^n P_{LK} + \sum_{k=2}^n P_{\text{Loss}}(k, k+1) - \sum_{k=2}^n P_{DG,k}. \quad (14)$$

(2) Voltage offset limitation:

$$|V_1 - V_k| \leq \Delta V_{\text{max}}. \quad (15)$$

(3) Feeder capacity limitation:

$$|S_k| \leq |S_{k,\text{max}}|. \quad (16)$$

(4) Distributed power capacity limitation:

$$P_{T,DG}^{\min} \leq P_{T,DG} \leq P_{T,DG}^{\max}. \quad (17)$$

Among them, $P_{T,DG}^{\min} = 0.1 \times \sum_{k=2}^n P_{LK}$, and $P_{T,DG}^{\max} = 0.6 \times \sum_{k=2}^n P_{LK}$.

(5) Radial structure limitation:

$$N_L = N_{br} - N_{bus} + 1. \quad (18)$$

N_L is 0, which means that the system topology after the feeder reorganization has no ring network. In the optimization process, if any point of the above constraints is violated, the optimization result is invalid.

2.5. *Optimization Process Based on Fireworks Algorithm*. This section introduces how to apply the evolutionary algorithm to the optimization of the distribution network, such as the selection of the number of fireworks, and the

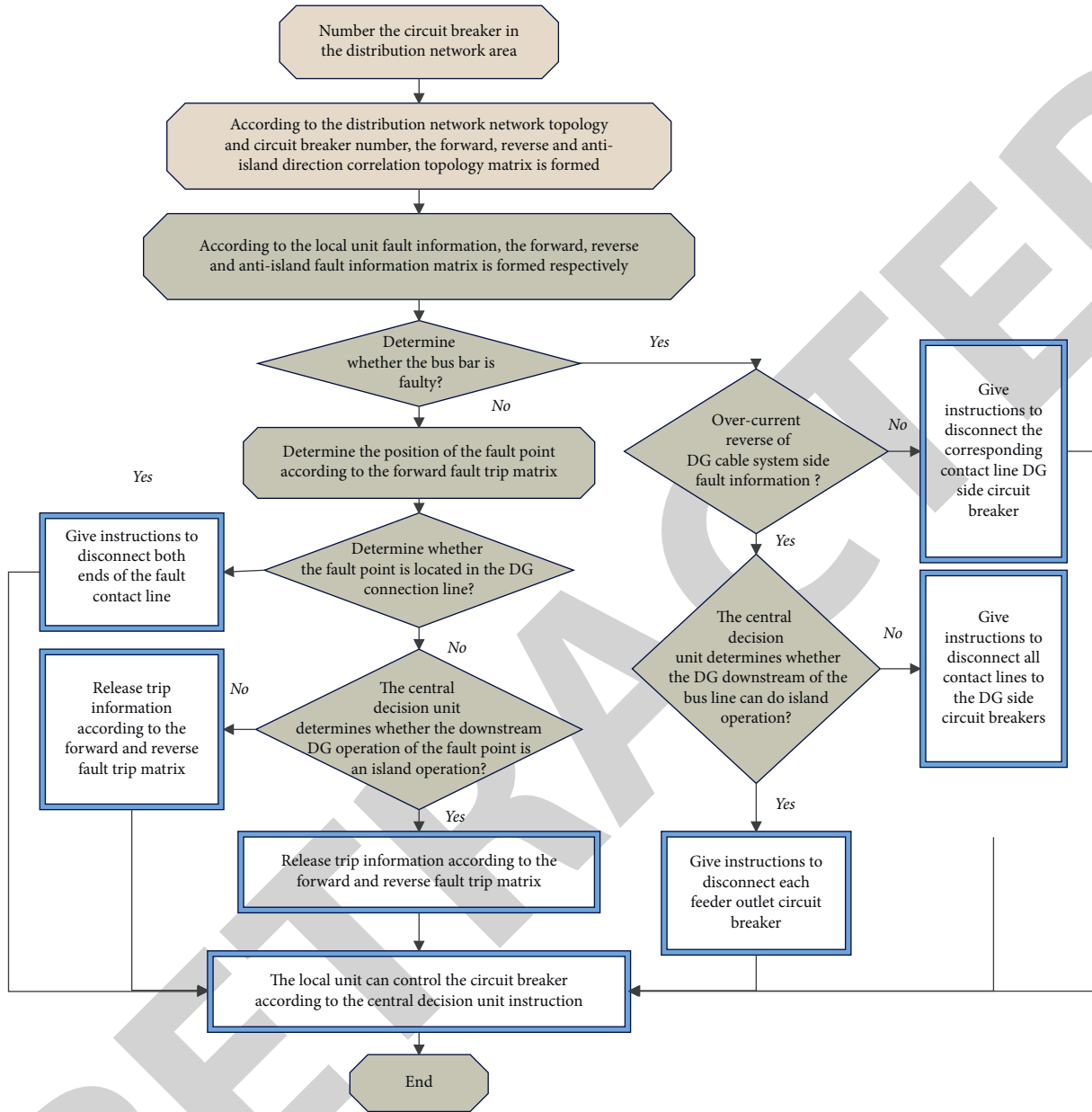


FIGURE 5: Principle of networked protection of distribution network connected to NE.

setting of each firework bit (gene bit). The main steps of applying fireworks algorithm to optimize distribution network structure and distributed power configuration are as follows:

Step 1: initializing fireworks algorithm parameters

- (1) N : the number of iterations of the algorithm, and in this section $N = 50$ is selected.
- (2) d : the dimension of the search space. This section should be set to the number of switches and distributed power sources for each “pseudoring network” partition described in Section 3. Here, it is set to 3, then the total problem dimension is $d = 5 + 3$.
- (3) n : the number of fireworks, and it is set to $n = 20$.

- (4) m : control variable for the total number of sparks.
- (5) A : maximum explosion radius.
- (6) Constants $s_{\min} = \text{round}(x \cdot m)$ and $s_{\max} = \text{round}(y \cdot m)$, where $x = 0.08$ and $y = 0.8$. Finally, the rounding operation is performed on s_{\min} and s_{\max} .

Step 2: the algorithm randomly selects n fireworks positions as follows, where Sw represents the tie switch and DG represents the distributed power supply capacity. The numbers on the right represent the self-numbers of the optimization variables, and the superscripts represent the number of fireworks. In this way, each line is a firework, and each firework can be regarded as a set of input parameters for a power flow calculation.

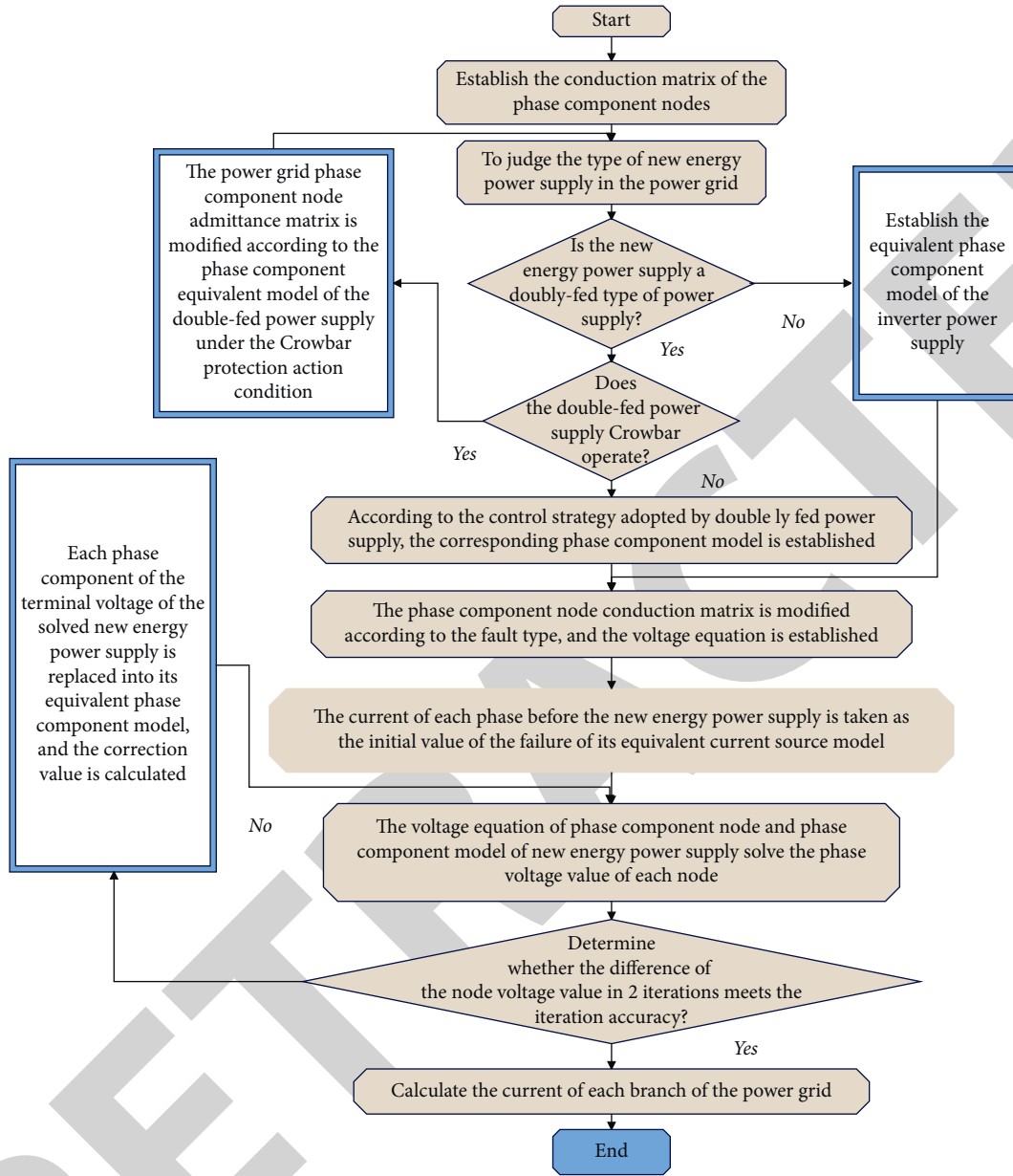


FIGURE 6: Flow chart of short-circuit calculation method for an unbalanced distribution network connected to NE.

$$FW = \begin{bmatrix} Sw1_1 & Sw2_1 & Sw3_1 & Sw4_1 & Sw5_1 & DG 1_1 & DG 2_1 & DG 3_1 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & v \\ Sw1_n & Sw2_n & Sw3_n & Sw4_n & Sw5_n & DG 1_n & DG 2_n & DG 3_n \end{bmatrix}. \quad (19)$$

In order to make the initialization of the matrix FW more convenient, and to avoid that the initialized matrix has no feasible solution, the algorithm generates the initialization matrix according to the following method [19]:

- (1) The algorithm inputs the network parameter matrix (node, branch, and parameters), and generates the “pseudoring network” branch array of the input network by generating the “pseudoring network” program.

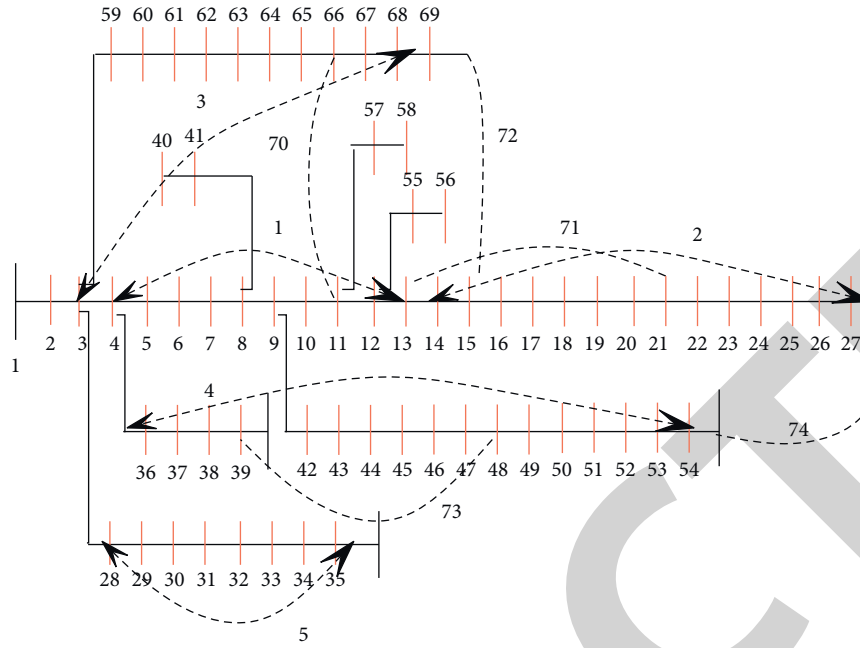


FIGURE 7: Test circuit.

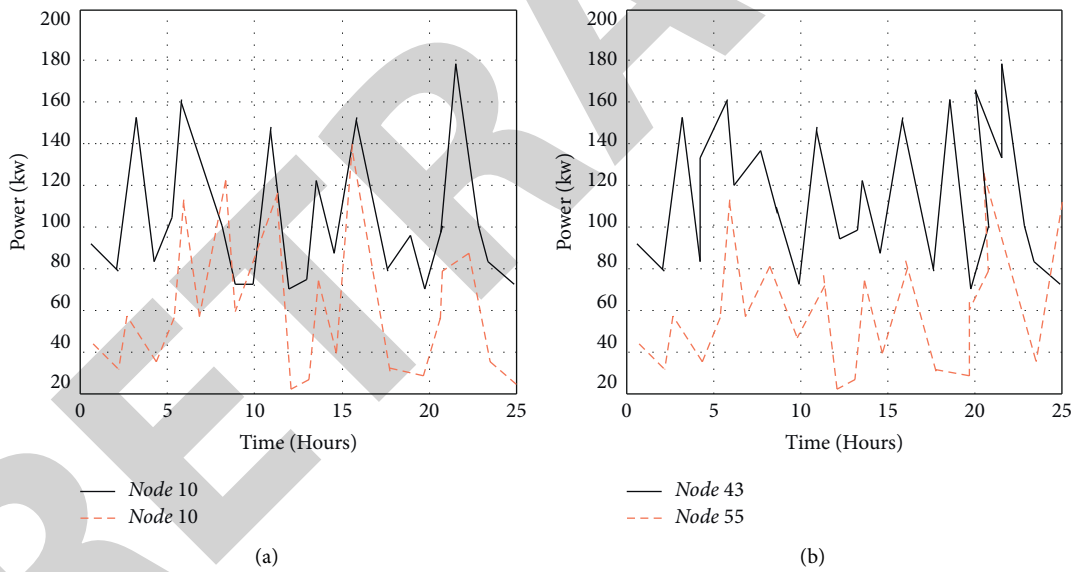


FIGURE 8: Wind farm output test of nodes.

- (2) The algorithm selects the shutdown branch node of each “pseudoring network” in the form of random numbers, and removes the shutdown branch from the original network parameters to form a new topology structure.
- (3) The algorithm passes through the ring network and island detection procedures. If the new structure does not generate ring networks and islands, the breadth-first numbering procedure is

used to renumber the network nodes to form a new input network parameter matrix. If a ring network or island node is generated, the algorithm returns to step 1, and the above 3 steps are repeated.

- (4) The algorithm randomly generates the capacity of the distributed power supply, forms a row vector of the matrix FW with the “pseudoring network” generated in step 3, and takes the row vector into

the power flow calculation program as an input parameter. If there is a power flow solution, the row vector is used as a row of the matrix FW.

- (5) The algorithm returns to step 1 to generate the second group of fireworks, until the number of fireworks reaches twenty, and the initialization ends.

Step 3: the algorithm releases the selected n fireworks, which in the power distribution system refers to the power flow calculation based on the selected set of variables.

In the first loop, the power flow calculation is performed for each row vector in the initial matrix.

Step 4: for the calculated results of each firework, $F(xp)$.

Step 5: in the same way, the algorithm calculates the Gaussian variation factor and calculates the fitness value.

Step 6: the algorithm compares the fitness value of the objective function of all operators (fireworks, sparks, and mutation sparks) and selects the fireworks with the smallest fitness value as the fireworks of the next explosion.

Step 7: the algorithm randomly selects from them to determine other $n-1$ new firework positions.

Step 8: if the above cycle does not reach the set maximum number of cycles, the algorithm returns to step 3. If the maximum value of the loop is reached, the algorithm jumps out of the loop and outputs each optimized variable value of the best fitness value.

The above are the main steps of applying the fireworks algorithm to the optimization of the distribution network feeder reorganization considering the distributed power configuration problem.

3. ACS of Multiemergency Power Supply Network System Connected to NE

In the networked protection system of the distribution network, the decision-making unit of the distribution network protection center is configured to realize the function of regional protection of the distribution network [20]. The local unit is equipped with a power distribution terminal, which mainly realizes the functions of local data collection and opening and closing control of the circuit breaker. The communication system mainly realizes the information exchange function between the central decision-making unit and each local unit. Figure 4 is a schematic diagram of the networked protection system of the distribution network.

The networked protection principle of the distribution network connected to NE is shown in Figure 5.

After the NE unit is connected to the power grid, there is a nonlinear relationship between the positive and negative sequence components of the fault current fed by the unit and the node voltage at the grid connection point of the unit. Therefore, the node voltage equation of the grid phase component can be jointly constructed and the short-circuit calculation model of the phase component of different types

TABLE 1: Effect evaluation of the ACS of the multiemergency power supply networking system connected to NE.

No.	Control effect
1	86.499
2	84.927
3	82.125
4	86.334
5	86.693
6	83.077
7	82.048
8	86.815
9	88.843
10	83.409
11	87.411
12	87.640
13	82.920
14	85.048
15	84.851
16	88.715
17	84.498
18	84.286
19	84.205
20	83.260
21	85.473
22	84.466
23	87.443
24	85.220
25	86.084
26	84.943
27	88.733
28	88.070
29	84.176
30	85.112
31	83.598
32	87.937
33	87.587
34	87.886
35	88.787
36	88.261
37	83.201
38	82.922
39	85.085
40	84.813
41	84.892
42	87.818
43	85.277
44	86.965
45	82.603
46	82.338
47	84.646
48	86.326

of NE units can be iteratively solved. Figure 6 is a flow chart of multiple types of NE sources [21].

The questions raised are tested on the PG&E69 node standard test system. In this paper, fans are configured at nodes 10, 18, 43, and 55 as shown in Figure 7.

The wind farm output test of the node is shown in Figure 8.

Based on the above analysis, the effect evaluation of the ACS of the multiemergency power supply network system connected to NE is carried out as shown in Table 1.

It can be seen from the above research that the ACS of the multiemergency power supply network system connected to NE proposed in this paper has the established effect.

4. Conclusion

As the common carrier of power transmission and power market, the power grid is the basic platform and main medium to ensure the development of NE. Therefore, the CD of NE and regional power grids is an inherent requirement and an inevitable choice to transform the energy structure and power development mode and achieve sustainable development. This paper proposes a method to optimize the distribution network feeder reorganization and distributed power configuration problems based on the fireworks algorithm to reduce the network loss and improve the voltage distribution. In addition, distribution network reorganization and distributed power configuration optimization can more effectively minimize network losses and improve voltage distribution. Through the experimental research, it can be seen that the ACS of the multiemergency power supply network system connected to NE proposed in this paper has the established effect.

Data Availability

The labeled dataset 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

This work was supported by 2019 Inner Mongolia Autonomous Region Science and Technology Project "Research and Demonstration Application of Multi-Emergency Power Networking Technology under Disaster Conditions" (2019GG373).

References

- [1] F. Xiao and Q. Ai, "Data-driven multi-hidden Markov model-based power quality disturbance prediction that incorporates weather conditions," *IEEE Transactions on Power Systems*, vol. 34, no. 1, pp. 402–412, 2019.
- [2] W. Qiu, Q. Tang, J. Liu, and W. Yao, "An automatic identification framework for complex power quality disturbances based on multifusion convolutional neural network," *IEEE Transactions on Industrial Informatics*, vol. 16, no. 5, pp. 3233–3241, 2020.
- [3] S. A. Kumar and D. Chandramohan, "Fault test analysis in transmission lines throughout interfering synchrophasor signals," *ICT Express*, vol. 5, no. 4, pp. 266–270, 2019.
- [4] F. Z. Dekhandji, S. Talhaoui, and Y. Arkab, "Power quality detection, classification and monitoring using LABVIEW," *Algerian Journal of Signals and Systems*, vol. 4, no. 2, pp. 101–111, 2019.
- [5] W. Qiu, Q. Tang, K. Zhu, W. Wang, Y. Liu, and W. Yao, "Detection of synchrophasor false data injection attack using feature interactive network," *IEEE Transactions on Smart Grid*, vol. 12, no. 1, pp. 659–670, 2021.
- [6] C. Liang, Z. Teng, J. Li et al., "A Kaiser window-based S-transform for time-frequency analysis of power quality signals," *IEEE Transactions on Industrial Informatics*, vol. 18, no. 2, pp. 965–975, 2022.
- [7] X. Deng, D. Bian, W. Wang et al., "Deep learning model to detect various synchrophasor data anomalies," *IET Generation, Transmission & Distribution*, vol. 14, no. 24, pp. 5739–5745, 2020.
- [8] A. Sundararajan, T. Khan, A. Moghadasi, and A. I. Sarwat, "Survey on synchrophasor data quality and cybersecurity challenges, and evaluation of their interdependencies," *Journal of Modern Power Systems and Clean Energy*, vol. 7, no. 3, pp. 449–467, 2019.
- [9] A. Khair, M. Zuhair, and M. Rihan, "Effective utilization of limited channel PMUs for islanding detection in a solar PV integrated distribution system," *Journal of the Institution of Engineers: Serie Bibliographique*, vol. 102, no. 1, pp. 75–86, 2021.
- [10] M. Asadi, M. N. Harikandeh, and M. Hamzenia, "Detecting and locating power quality issues by implementing wavelet transform," *International Journal of Science and Engineering Applications*, vol. 10, no. 07, pp. 96–100, 2021.
- [11] W. Wang, C. Chen, W. Yao, K. Sun, W. Qiu, and Y. Liu, "Synchrophasor data compression under disturbance conditions via cross-entropy-based singular value decomposition," *IEEE Transactions on Industrial Informatics*, vol. 17, no. 4, pp. 2716–2726, 2021.
- [12] S. Vlahinić, D. Franković, B. Juriša, and Z. Zbunjak, "Back up protection scheme for high impedance faults detection in transmission systems based on synchrophasor measurements," *IEEE Transactions on Smart Grid*, vol. 12, no. 2, pp. 1736–1746, 2021.
- [13] B. K. Panigrahi, A. Bhuyan, J. Shukla, P. K. Ray, and S. Pati, "A comprehensive review on intelligent islanding detection techniques for renewable energy integrated power system," *International Journal of Energy Research*, vol. 45, no. 10, pp. 14085–14116, 2021.
- [14] P. K. Ganivada and P. Jena, "Frequency disturbance triggered d-axis current injection scheme for islanding detection," *IEEE Transactions on Smart Grid*, vol. 11, no. 6, pp. 4587–4603, 2020.
- [15] X. Xie, Y. Zhan, H. Liu, and C. Liu, "Improved synchrophasor measurement to capture sub/super-synchronous dynamics in power systems with renewable generation," *IET Renewable Power Generation*, vol. 13, no. 1, pp. 49–56, 2019.
- [16] E. M. Molla, C. H. Liu, and C. C. Kuo, "Power quality improvement using microsystem technology for wind power plant," *Microsystem Technologies*, vol. 26, no. 6, pp. 1799–1811, 2020.
- [17] R. M. Radhakrishnan, A. Sankar, and S. Rajan, "Synchrophasor based islanding detection for microgrids using moving window principal component analysis and extended mathematical morphology," *IET Renewable Power Generation*, vol. 14, no. 12, pp. 2089–2099, 2020.
- [18] Y. Hao, M. Wang, J. H. Chow, E. Farantatos, and M. Patel, "Modelless data quality improvement of streaming synchrophasor measurements by exploiting the low-rank Hankel structure," *IEEE Transactions on Power Systems*, vol. 33, no. 6, pp. 6966–6977, 2018.

Retraction

Retracted: Ecological Concept of Basic Computer Vision and Visual Communication of Advertising under the Concept of Ecological Design

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. Zhang and J. Wenyue, "Ecological Concept of Basic Computer Vision and Visual Communication of Advertising under the Concept of Ecological Design," *Security and Communication Networks*, vol. 2022, Article ID 8392918, 11 pages, 2022.

Research Article

Ecological Concept of Basic Computer Vision and Visual Communication of Advertising under the Concept of Ecological Design

Ao Zhang¹ and Jin Wenyue² 

¹College of Arts and Media, Suqian University, Suqian 223800, Jiangsu, China

²College of Arts and Information Engineering, Dalian Polytechnic University, Dalian 116400, Liaoning, China

Correspondence should be addressed to Jin Wenyue; 320134700074@ustl.edu.cn

Received 4 July 2022; Revised 27 July 2022; Accepted 13 August 2022; Published 9 September 2022

Academic Editor: Tao Cui

Copyright © 2022 Ao Zhang and Jin Wenyue. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

With the importance people attach to the harmony of ecosystem in modern society, the concept of ecological design has been adopted in some industries and is gradually being valued and recognized by people. In real life, advertising design and production is an important field of art design. With the rapid development of society and the continuous updating of network information technology, network advertising and visual communication design inevitably collide. As a new form of advertising, network advertising had become a part of people's network life. This paper analyzes the technical characteristics of image transformation, image enhancement, image restoration, image coding, and image recognition in computer vision processing. Through the image processing algorithm and program of computer, the advertising image can be processed to realize the functions of recognition, restoration, coding, enhancement, and transformation of advertising image. This thesis had studied the visual communication design in modern online advertising under the concept of ecological design. Using computer vision processing technology, this thesis had studied how to process the ecological concept and advertising visual communication content through computer vision technology, which will help to better improve the configuration of online advertising and create a more pleasant visual environment. It is of great significance to promote the rapid development of online advertising industry.

1. Introduction

In today's environmental pollution problem which is increasingly serious, we have to think independently about how to flexibly use the limited resources provided, of course, to promote the social and economic development of physical and mental health and sustainable development concept. Ecological design with ecological environment protection and environmental resource protection as the core value should emerge and become a development trend. Ecological design is also known as emerald green design, life cycle design, or natural environment design [1]. Integrating environmental factors into the design is conducive to clarifying the direction of decision design. The requirement of ecological design is to take into account environmental factors

in all stages of new product development, reduce the role of all commodity life cycle on the environment, and finally form a more sustainable demand and supply management system [2]. In real life, along with the prosperity of people's life and the development of network technology, modern advertising design and production is an indispensable work of wide attention. Modern advertising also grew rapidly, becoming part of the environment they grew in. As an advertising designer, advertising design should pay attention to everyone's healthy lifestyle and apply the core concept of greener ecological design to the design and creation of modern advertising, which is also the responsibility of advertising designers to nature and society.

With the rapid development of network information technology, make full use of the role of the network,

advertising, and promotion of information content, and gradually form an important way of contemporary corporate image publicity and marketing. With the rapid development of Internet technology and the rise of the Internet, the contemporary Internet advertising, visual communication design, and design research are of important practical significance. The research on the effect of visual communication design of modern online advertising will help to create a more pleasant visual environment and effectively promote the rapid development of the online advertising industry. The current industry survey of advertising visual communication is shown in Figure 1, which reflects the current education and training, media, clothing, real estate, interior decoration, and other industries related to advertising visual communication, and gives the approximate proportion of industries. In the current industries involved in advertising visual communication, real estate and interior decoration account for about 15%, traditional advertising and media account for nearly 10%, and other industries such as the Internet, clothing, education, and training account for less than 7%.

Meanwhile, the continuous popularization of computer technology has been developing. Computer technology has become an indispensable part of the development trend of [3]. In order to realize the artificial intelligence of computer, in order to make the computer can better process and show the image information, must computer visual processing technology. At present, computer technology has been able to analyze and process 2D images and 3D structures, and identify and analyze 2D image content. In practical application, the computer can carry out a deep analysis of the three-dimensional structure, to meet people's intelligent requirements. Considering the concept of green ecological design, this paper discusses how to use computer vision technology to solve the green ecological concept and visual communication design of advertising [4].

2. Technical Status Analysis

2.1. Value of Ecological Design Concept. Environment is what people survive and develop in. In recent years, due to the rapid development of society and economy and the rapid development of ecological resources, China's ecological environment has been damaged, seriously endangering people's lives and harming people's health. As a result, more and more people begin to pay attention to the harmony of the ecosystem and realize the importance of protecting the environment. The green ecological design idea has penetrated into all fields of social development and life, and has been recognized and highly valued by the public. Important use value of green and environmental protection design is shown in Figure 2. In the circle of ecological design, production, use, and reuse are the main links to achieve the goal of reducing the environmental burden.

2.2. Ecological Concept and Advertising Visual Communication. The design and production of the current advertising and its design and production should be

integrated into the ecological concept, so as to produce huge advertising utility. Advertising is a way of promoting information to users. The essential element of advertising is to convey information. Contemporary advertising design and production are in conveying the content and form of advertising, and we should pay more attention to the visual effect communication and emotional communication, resulting in the empathy of the audience. From the perspective of market sales, advertising has a certain guiding role, but this guiding effect is based on the ability to grasp the psychological state of the audience. Advertising interior designers should predict and analyze the audience's psychological reaction after watching the advertisement and capture this psychology reasonably, so as to guide the advertising design specifically. People pay more and more attention to green ecology and health. If the ecological concept is combined in advertising, the public will know that the product is green and pollution-free, and can meet the personal needs of users while improving environmental awareness. The design content of advertising visual communication under ecological concept is mainly shown in Figure 3. The leaflets, catalogues, posters, business cards, e-mails, advertising, and other methods involved in advertising communication under the ecological concept obtained from the investigation.

In the process of modern advertising design and production, it is very meaningful to combine the ecological concept of advertising design. The subject of advertising design is human, and the recipient of advertising is also human. Therefore, in the process of ecological advertising design, we should also pay attention to the people-oriented design principle and consider the inner appeal of the audience, so as to gain the audience's recognition. At present, eco-concept advertisements advocate the concept of green development when displaying corresponding product contents, aiming to provide the audience with better quality, and more intuitive and more intelligent comprehensive media communication services. Incorporating ecological civilization design concept [5] into advertising design and production process can not only effectively promote products, but also effectively promote the concept of ecological civilization, green development, environmental morality, environmental rule of law, and environmental literacy of the whole people.

2.3. Computer Vision Technology. In the advertising design of communication content through visual media design, the publisher of information is the interior designer, and the participant of information is the goal of information transmission. The rapid development of multimedia not only affects the traditional visual transmission method, but also adds great challenges to visual transmission, from a single news media to multimedia, from static data to dynamic, from the surface to multi-dimensional, from information virtualization technology [6], dynamic integrated advertising design to the comprehensive direction. With the improvement of advertising forms, digital information advertising, multimedia electronic device display, multimedia communication, and other ways have been widely used in advertising.

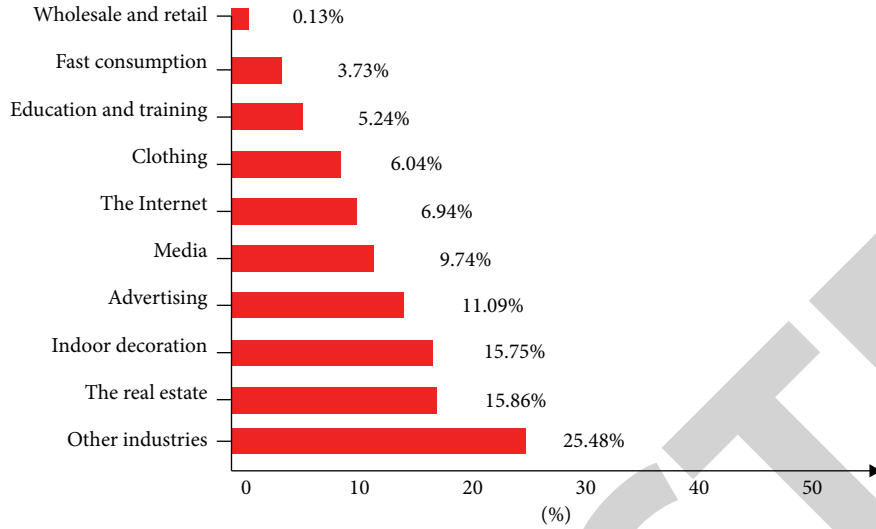


FIGURE 1: Proportion of industries involved in advertising visual communication.

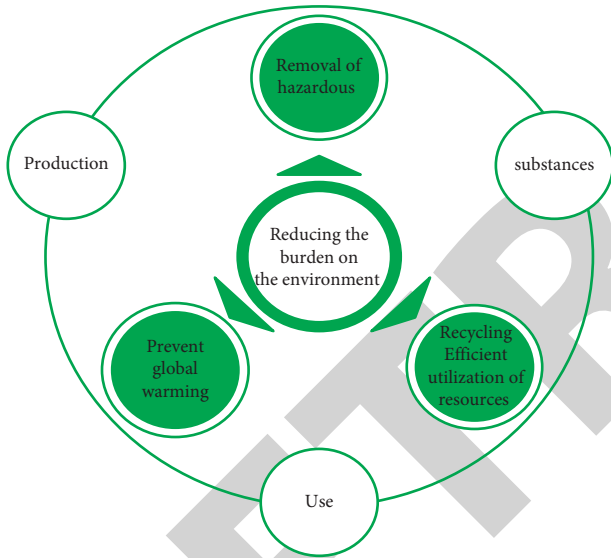


FIGURE 2: Main values of ecological design.

Computer vision technology refers to the whole process of observing and analyzing images by using computers to simulate human vision [7]. It stipulates that the electronic computer has the image identification level of artificial intelligence technology process, simulates the whole process of human vision effect, and completes the intelligent system of related image processing. The software system architecture is shown in Figure 4. This paper describes the acquisition and processing of image data, image characteristic positioning and segmentation, and image professional knowledge matching and learning.

Electronic computer technology is an artificial intelligence technology that simulates the whole process of our cognitive environment. Therefore, the technology integrates digital image processing, artificial intelligence technology, data technology [8], and other disciplines and technologies. This technique is different from the machine vision

techniques, as shown in Table 1. Machine vision technology is not only suitable for computer development and design, but also has a certain application in mechanical automation production. In the future automated machinery production, this technology can obtain objective things for the detection and control technology in production. Compared with the traditional automatic control system, it can achieve rapid, more information, and more manipulation of [9].

2.4. Computer Vision Technology Analysis. From Figure 5, the relevant information of the object image is collected first, and then the appropriate background photo object image is selected, so that the background of all objects is consistent and prevents the influence of background factors in the later image processing. In image collection, a process of printing out an image cannot be controlled, so it will also be affected by external factors. The expression form is more noisy, and the collected images should be effectively denoised to prevent the follow-up work and the accuracy of the test results.

The perimeter is the length of the entire area around the edge of the object in the image, which is the circumference of the object. The contour information of the object in the figure is extracted, all pixels of the object boundary are calculated to obtain the sum of pixels, and the result of the object's perimeter feature can be obtained. Here, the perimeter should be calculated in accordance with

$$L = \sum_{x=0}^{N-1} \sum_{y=0}^{M-1} f(x, y). \tag{1}$$

If the object has been through area information extraction, it can be learned that the roundness of the object is inversely proportional to its circumference. At this time, after the area and circumference of the object are calculated, the roundness of the object can be calculated to determine which quality level the shape of the object is in. At this point, the relationship between circumference and radius of the

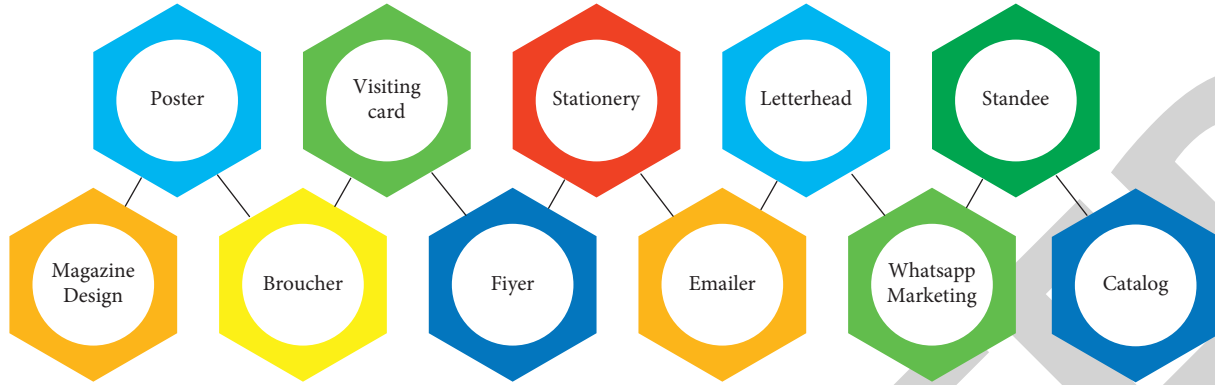


FIGURE 3: Main components of advertising visual communication.

object can be calculated according to Formula (2) and Formula (3).

$$\begin{aligned}
 L &= 2\pi r_1, \\
 r_1 &= \frac{L}{2\pi}, \\
 S &= \pi r_2^2, \\
 r^2 &= \sqrt{\frac{S}{\pi}}.
 \end{aligned} \tag{2}$$

Because the actual shape of the object is not a standard circle, there will be some difference between the calculated value of the radius of the object in the above formula and the actual value of the radius of the object. At this point, the ratio of the two sets of radius solution results can be squared to measure the roundness of the object itself. The closer the ratio is to 1, the more standard the shape of the object itself is. At this point, we can deduce formula (4) for calculating the roundness of the object.

$$c = \left(\frac{r_2}{r_1}\right)^2 = \frac{S/\pi}{L^2/(4\pi^2)} = \frac{4\pi S}{L^2}. \tag{3}$$

The size of the plane that the image of the object occupies, that is, the area we are talking about here, is the object obtained by removing the background.

At the initial stage of the image binarization process, the foreground of the image object has been processed as a white part, and the background color has been processed as a black part. To solve the object area here, we need to get the additive income of all white pixels in the foreground, that is, to find the solution within the boundaries of all pixels. In order to calculate the number of maps $f(x, y) = 1$, the relationship between the pixel points and the area is solved according to the following formula:

$$S = \sum_{x=0}^{N-1} \sum_{y=0}^{M-1} F(x, y) |_{f(x,y)=1}. \tag{4}$$

Image processing operations, steps, and experimental results are shown in Table 2.

The specific process of image segmentation is shown in Figure 6. The necessary defect characteristics should also be obtained according to the calculation. Observe the object image and understand the segmented image information content of the difference in the normal area in the image. According to the environment removal, observe the color change of the object image, and find that many pixels are different. At this point, the target image was tested to obtain a modest threshold cut-off. The relationship between pixels and threshold is resolved for all pixels in future gray-value image resolution. If the pixel itself is below the threshold value, use a specific pixel. The number is gray and black, and the number is 255 in white. At this time, assigned from the pixel to the defect, the white image on the surface is part of the defect.

3. Modern Advertising Visual Communication Solutions

3.1. Application of Computer Vision Technology. In the visual communication of modern advertising, the application of computer vision technology involves industries as shown in Figure 7.

The application of computer vision technology is mainly divided into the following parts: this is also the basic content of machine vision technology in image processing. This technology is designed to achieve fast image resolution and analysis. This uses [10] to convert the image of a special space into a linear function and shows it in different spaces and ways. In addition, special computer optimization algorithms, image processing, and image transformation are also applied to convert the image into the initial image space, and the processed and modified images can show specific actual effects as shown in Figure 8.

3.1.1. Image Enhancement. Image enhancement refers to the process of image processing and refers to modifying and processing the original image with the help of a series of algorithms, so as to change all kinds of information in the original image and provide better visual effects for human beings. The most common image enhancement application is what people call beauty function, which is to use a series of image enhancement means to continuously

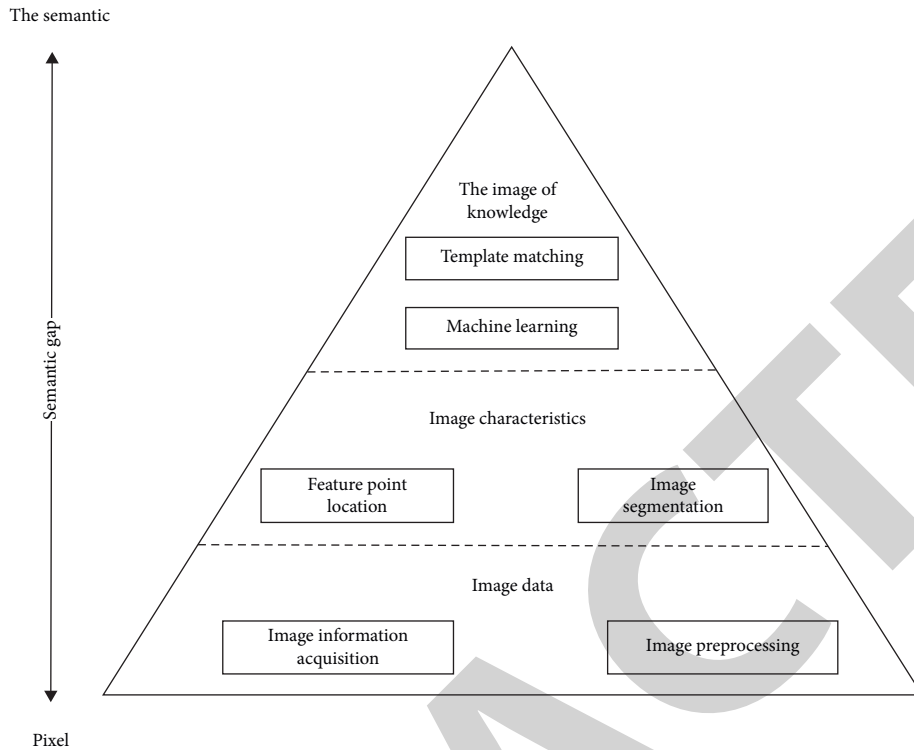


FIGURE 4: Computer vision technical framework.

TABLE 1: Differences between computer vision and machine vision.

Computer vision contrasts machine vision with connection			
	Industrial machine vision (MV)	Artificial intelligence (AI)	Consumer computer vision (CV)
Category			
Discipline	Systems engineering		Computer science
Constitute	Hardware and software		Software dominated
Perception	Single sensor is the main and is moving to multi-sensor fusion		Combined use of multiple types of sensors and fusion technology
Application focus	More emphasis on generalized image signal (laser, camera) and automatic control (production line)		More attention is paid to the (2/3D) image-related interdisciplinary research
Content	Algorithms such as image acquisition, lens control, and image processing.		Image processing algorithms
Controllability	More controllable		The uncertainty is greater
Core	Technology that allows robots to identify according to their tasks		Techniques for how to perform image analysis

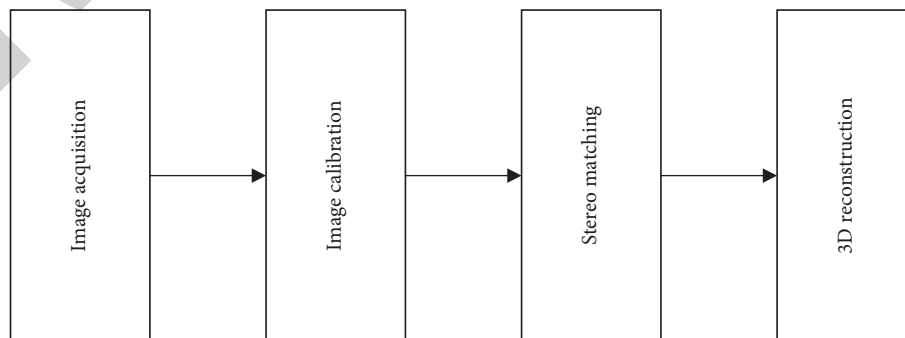


FIGURE 5: Four steps of image processing.

TABLE 2: Basic image processing operation table.

Serial number	Operation	Steps and results								
1	The original image grayscale	0	1	2	3	4	5	6	7	
2	The original histogram is each grayscale pixel	790	1023	850	656	329	245	122	81	
3	Original histogram $P(r)$	0.19	0.25	0.21	0.16	0.08	0.06	0.03	0.02	
4	Original cumulative histogram $V1$	0.19	0.44	0.65	0.81	0.89	0.95	0.98	1	
5	Prescribe a histogram $P(z)$	0	0	0	0.15	0.2	0.3	0.2	0.15	
6	Specifies the cumulative histogram $V2$	0	0	0	0.15	0.35	0.65	0.85	1	
7	Minimal mapping $ V2-V1 $	3	4	5	6	6	7	7	7	
8	Determine the mapping relationship	0 \rightarrow 3	1 \rightarrow 4	2 \rightarrow 5	3, 4 \rightarrow 6		5, 6, 7 \rightarrow 7			
9	Postswap histogram	0	0	0	0.19	0.25	0.21	0.24	0.11	

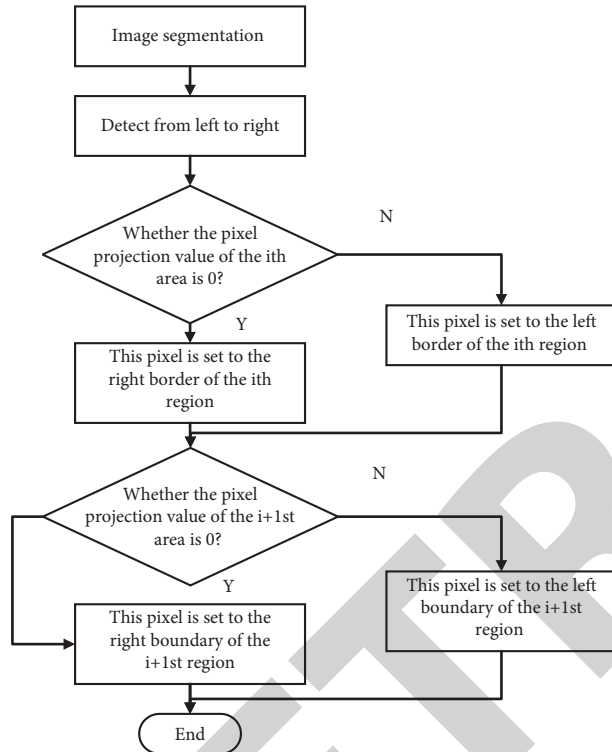


FIGURE 6: Image segmentation process.

process the original image and then present a more beautiful beauty effect for human beings.

3.1.2. Image Restoration. Also known as image link [11], this technology is easily understood by people. It is to improve image quality by means of image information processing and restore the original high-definition image. In the specific application process of image restoration, the corresponding algorithm should be adopted to reduce the interference of digital image in the acquisition process of relevant image capture equipment and reduce the impurities caused by the acquisition equipment itself.

3.1.3. Image Coding. A variety of technologies, also known as image compression [12], occur because the image itself has a large amount of data. In order to achieve the 3D rendering and analysis of the image, less data are necessary to achieve the detailed solution of the image, so some kind of

compression method should be used to reduce the image data. When you compress an image, you first need to understand what data are redundant in the image. Below, use multiple bits to represent such data [13]. This can effectively compress the data in the image, and store and transmit the image, An image digital recognition is shown in Table 3.

3.1.4. Image Recognition. Image recognition: This is also the most common exposure to machine vision technology. It refers to the use of relevant optimization algorithms and recognition methods to screen and identify the image content, and uses machine intelligence to replace the human eyes to complete the image of real-time automatic monitoring [14]. The image classification and identification plan scheme can better identify and process the content in the image, which is the key content to promote the intelligent measurement, as shown in Figure 9.

3.2. Advertising Visual Communication Design. Advertising visual communication design is a modeling activity that spreads information and emotion to the public with visual media as the carrier. Visual communication design covers a wide range, including all kinds of graphic design, but also covers new communication media such as network and video. Through the processing, design, and innovation of layout, text, color, and other elements, it is conveyed to the audience [15]. The traditional advertising visual communication channels and characteristics are mainly shown in Table 4. Through the above key technologies in computer vision processing, such as image recognition, image coding, and image restoration, we can process the visual communication effect of traditional advertising.

The main characteristics of visual communication design are reflected in three aspects: visual competitiveness; interaction between communicator and audience; and globalization of visual communication forms [16]. The application of visual communication design in online advertising can not only enhance the display effect of advertising and improve the communication rate of advertising content, but also achieve better interaction between the communicator and the audience, as shown in Figure 10.

3.2.1. Theme Elements. The success of online advertising must be based on the realization of theme objectives, and the accurate expression of these ideas to the audience is

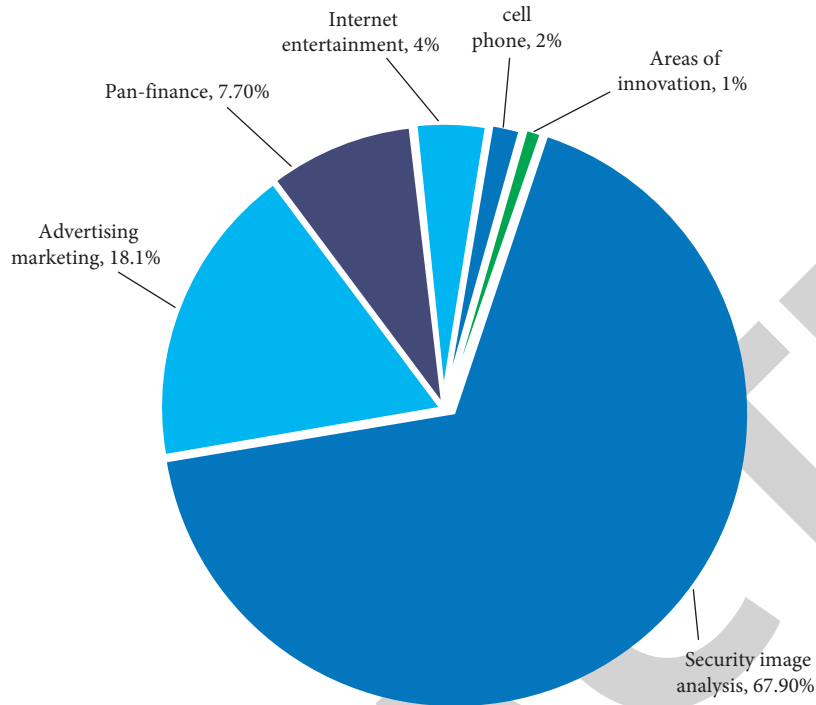


FIGURE 7: Computer vision application survey.

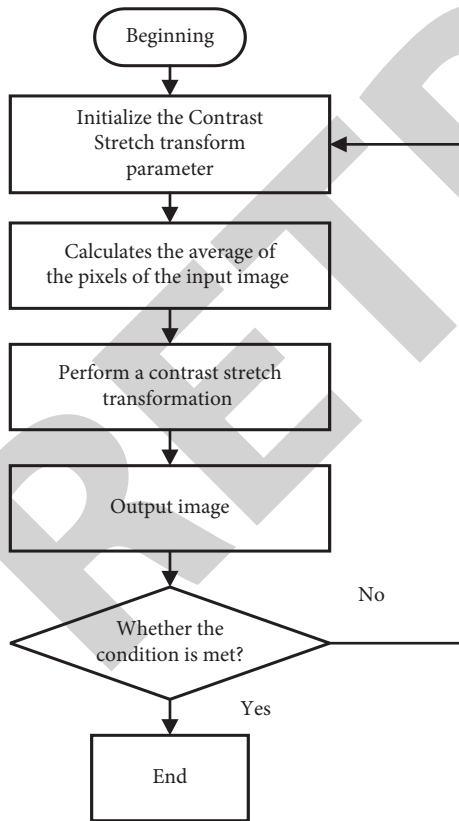


FIGURE 8: Image transformation process.

as to accurately achieve the dissemination of advertising themes. In the visual communication design of online advertising, determining the theme content of the design is the first and last step. The subsequent application of text elements, layout elements, and color elements is always carried out around the theme content. Therefore, the theme element is the key to the visual communication design of online advertising.

3.2.2. Text Element. Because of its unique expressive force, text has irreplaceable importance in modern network advertising. The information of network advertisement often needs a certain text description to appear fuller, and its different visual expression forms, such as graphic text, bring different emotional communications to the audience. In online advertisements, the visual form of text generally has two forms, namely, graphic text and text text [17].

3.2.3. Layout Elements. Successful layout design can clearly convey the main idea, which is more convenient for people to read and participate in. On the one hand, it is necessary to arrange the visual elements that are easy to attract the attention of the audience according to the characteristics of the target of online advertising information. On the other hand, controlling the proportion of pictures and words in layout design, and displaying important words in striking fonts or colors can also ensure better results. At the same time, adjust the proportion of text and picture in network advertisement according to the main content to ensure the harmony of web page layout. Rich layout should pay special attention to the reasonable guidance of the visual process, so as to catch

inseparable from the continuous pursuit of novelty and creativity. Displaying creative visual language through unconventional ways can attract people's special attention, so

TABLE 3: Digital recognition record of an image.

Digital	Number of intersections with Y	Number of intersections with X1	Number of intersections with X2	Classification
0	2	2	2	A
1	1	1	1	B
2	3	1	1	C
3	3	1	1	C
4	2	2	1	D
5	3	1	1	C
6	3	1	2	E
7	2	1	1	F
8	3	2	2	G
9	3	2	1	H

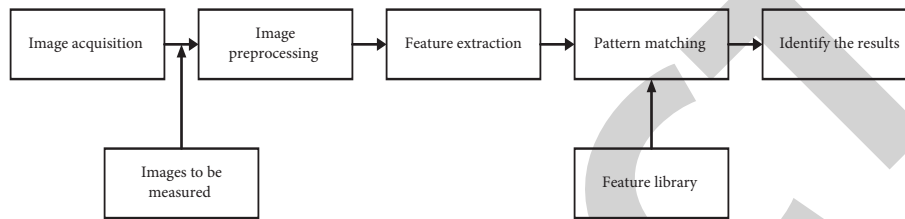


FIGURE 9: Image recognition process.

TABLE 4: Comparison of traditional advertising visual communication channel.

Project	Merit	Shortcoming
Newspaper	<ul style="list-style-type: none"> Short lead times for ad purchases Information can be passed over a certain area Ad sizes are flexible High acceptance and reading rates Free help is often available 	<ul style="list-style-type: none"> Less impact on customers under the age of 18 Reading is rushed Too much advertising content Poorly targeted Poor ad quality
Magazine	<ul style="list-style-type: none"> Highly targeted Reader acceptance is high Low cost and good quality 	<ul style="list-style-type: none"> Invalid ads Longer lead time for purchase Circulation is not large
TV	<ul style="list-style-type: none"> Sound and image combined Many viewers Low cost per viewer 	<ul style="list-style-type: none"> Poorly targeted Viewers spend a short time watching ads High overall cost
Broadcast	<ul style="list-style-type: none"> Wide range Highly targeted Fast and flexible Good psychological effect 	<ul style="list-style-type: none"> Unable to pass image Information is fleeting Not impressed Clutter and noise

people's sight from beginning to end, enhance people's attention to the advertising information while strengthening the understanding, and better convey the advertising information.

3.2.4. *Color Elements.* Whether the use of color is appropriate benefits will be directly related to the success or failure of online advertising. Color has a strong expressive force, and it can profoundly affect people's emotional state. At the same time, reasonable collocation of different colors can create perfect artistic effects in line with the content and theme of advertisements [18]. The effective use of color elements in online advertising will greatly improve the visual impact of the audience and arouse the emotional resonance of the audience. Therefore, designers must correctly understand the inner meaning, relationship, and law of

different colors, so as to flexibly use them in online advertising design.

4. Application Analysis and Results

4.1. *Advertising Visual Communication Design Content.* With the development of diversified media based on electronics, print-oriented advertisements gradually extend to the field of multimedia technology, and advertisements gradually change from static signboards to electronic flip boards, LED displays, and other new forms [19]. Modern advertising composed of shop signs, curtain wall advertising, light box advertising, dazzling lights advertising, wall advertising, banners, gas model advertising, etc. Due to the variety and complexity of its contents, it is necessary to design advertisements reasonably considering the environment and visual impact. In advertising design, the

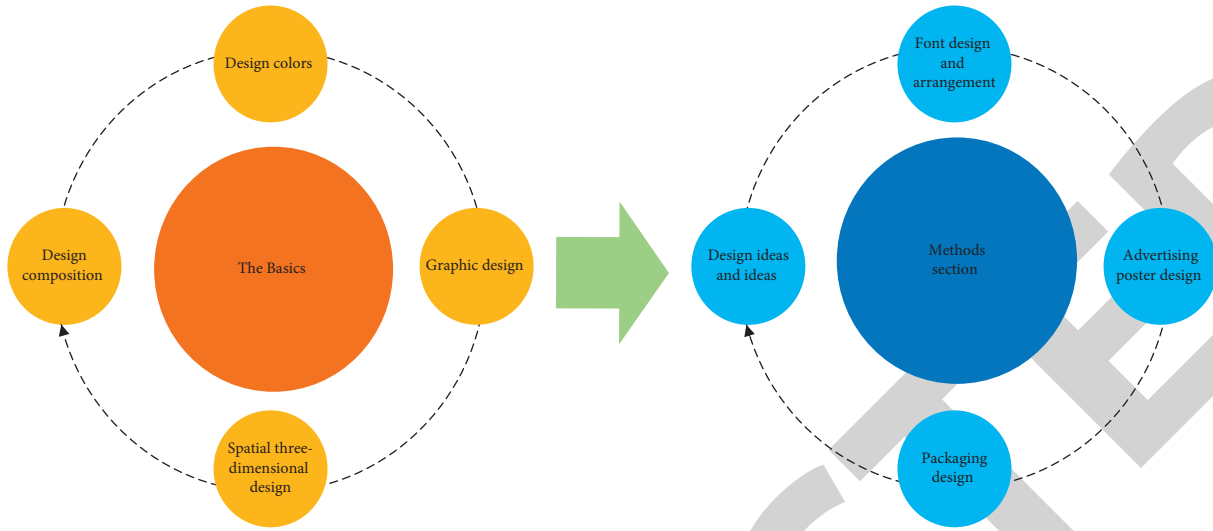


FIGURE 10: Composition of advertising visual communication design.

audience’s visual instant perception, namely, the first impression, is particularly important, which is one of the conditions to determine the effectiveness of advertising. The basic operation content is shown in Figure 11.

The regionalization of spatial characteristics is influenced by factors such as spacing, size, appearance, dynamics, static data, and deep layers. Visual science research can avoid the problems caused by visual cognitive ability in advertising design. Visual science research can conduct [20] in both psychology and physiology. Visual rate, visual acuity, and visibility are suitable for functional measures of vision. The form and proportion of advertising are related to the first impression of the audience group. Sign color proportion, appearance, size, and relative height must conform to the scientific and reasonable proportion.

Advertising art creativity is a clever artistic creativity, highlighting the characteristics and essential characteristics of new products, with the support of multimedia technology, to deliver the creative content that must be expressed to consumers. Excellent advertising art creativity can arouse consumers’ consumption awareness, promote consumers’ purchase willingness, and correctly guide consumers to trade. Interior designers apply contemporary multimedia technology to turn the advertising interface from static data into dynamic, stimulate consumers’ visual experience, promote consumer resonance points, promote consumer behavior, and at the same time, improve the artistic beauty and communication effect of advertising. The diversity of electronic information and media has driven the rapid development of the whole society. Visual delivery design scheme has also undergone a change from traditional methods to digital information.

4.2. *Future Development of Advertising Visual Communication.* Nowadays, the development of electronic information technology has brought new development opportunities for advertisers. More efficient and environmentally friendly advertising equipment can save advertising

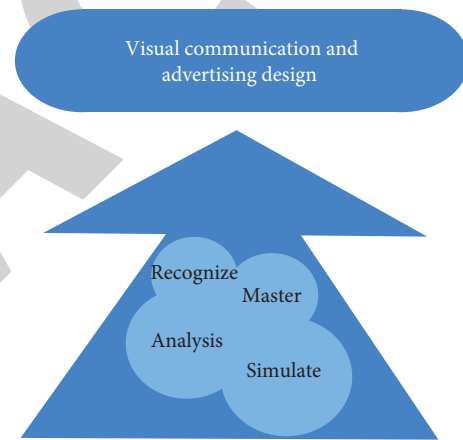


FIGURE 11: Visual communication advertising design content.

investment, improve the effect of advertising visual communication, and meet the needs of modern city development while realizing the maximization of interests. China advocates the concept of “energy saving” and “environmental protection” [21]. The new technologies, such as energy saving and environmental protection, ultraviolet shielding technology used in display and flip screen, and data integrated manipulation, have promoted the rapid development of advertising visual communication design, and the construction and rapid development of urban low-carbon environmental protection construction and beautification. Therefore, the visual communication design of contemporary urban advertising has made great contributions to the urban development and urban image construction. In the economic development of contemporary news media, the sharing economy mode is dominant. It will become the future development trend to complete the sharing of advertising resources and advertising planning activities among news media. It is a trend to integrate the data information of advertising websites, data networks, and social media. Advertisers can know how consumers respond to advertisements and publish them more

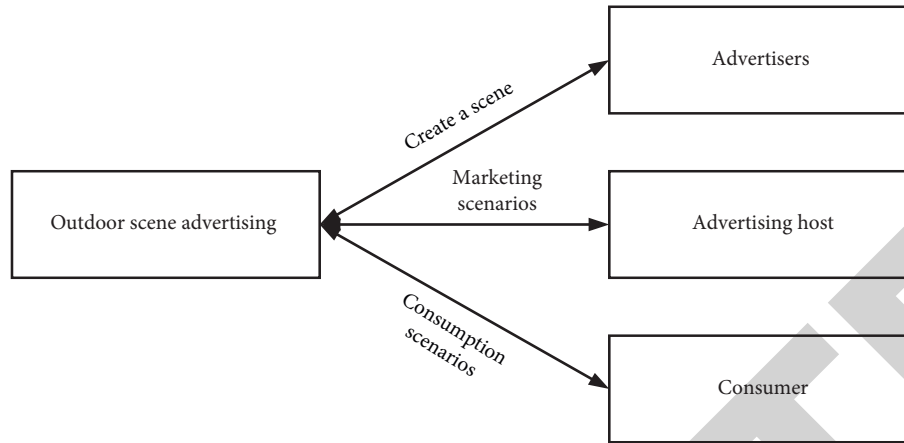


FIGURE 12: Composition of scene advertisement.

appropriately and scientifically. Advertising and marketing according to the scenario are also very important, as consumers have different understandings and experiences of the product in different scenarios as shown in Figure 12.

Therefore, the visual effect of modern advertising consists of frame and form of expression [22]. First, the advertising design renderings are composed of illustrations, article title, text, registered trademark, boxes, and so on. Because these factors can be placed in appropriate parts to spread the actual effect of advertising, the advertising composition interface must be improved. The expression of the store recruitment Cheng advertising is simple and clear, and the backlight and text picture billboard advertising will be the store design style to show incisively and vividly, and pedestrians at a glance. Similarly, the wall advertisements on the roof are simple color matching, a single font way. Targeted design according to color, illustration, text, etc. can achieve better advertising visual effect. The size of advertising illustrations, virtual reality technology, color, black and white, appearance, etc. will affect the communication effect. .

5. Conclusion

In a word, more and more people follow the harmony of the ecosystem and realize the importance of protecting the environment. The idea of green ecological design has penetrated into all walks of life of social development and has been recognized and highly valued by the public. Computer vision technology is an extremely important technology, and it is of great help to human work. In the development of future work, computer vision technology will develop in a more intelligent direction and help to various fields. With the development of a variety of media with Internet media as the main body, advertising creativity has gradually expanded to the multimedia system technology industry, stimulating the visual effect of customers, arousing customer resonance points, promoting consumer behavior, and improving the artistic beauty and communication effect of advertising. With the rapid development of social development and the continuous innovation of information network technology,

Internet advertising and visual communication professional will inevitably dispute. As a new form of advertising, online advertising has become a part of people's online life. It is of great significance to study the visual communication design of modern online advertising under the ecological design concept and use computer vision processing technology to better perfect the configuration of online advertising and create a more pleasant visual environment, which is of great significance to promote the rapid development of online advertising.

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

This work was supported by Dalian Polytechnic University.

References

- [1] Xiaomin Ren, "Value and application of Chinese elements in graphic advertising design," *Industry and Technology Forum*, vol. 19, no. 4, pp. 145-146, 2020.
- [2] C. M. Yeum, S. J. Dyke, and J. Ramirez, "Visual data classification in post-event building reconnaissance," *Engineering Structures*, vol. 155, no. 15, pp. 16-24, 2018.
- [3] W. Li, "Research on the application of graphic creativity in graphic advertising design," *Art Overview*, no. 5, pp. 25-26, 2020.
- [4] B. Conde-Carnero, B. Riveiro, P. Arias, and J.C. Caamano, "Exploitation of geometric data provided by laser scanning to create FEM structural models of bridges," *Journal of Performance of Constructed Facilities*, vol. 30, no. 3, 2016.
- [5] J. Ma, Xi Liu, and Y. Yang, "Application of computer vision technology in Part Identification," *China Equipment Engineering*, no. 21, pp. 244-246, 2020.

Retraction

Retracted: On the Design of Assistant Teaching Using Network Multimedia Database in Volleyball Teaching

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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.

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] J. Yin and Q. Song, "On the Design of Assistant Teaching Using Network Multimedia Database in Volleyball Teaching," *Security and Communication Networks*, vol. 2022, Article ID 8684007, 10 pages, 2022.

Research Article

On the Design of Assistant Teaching Using Network Multimedia Database in Volleyball Teaching

Juan Yin  and Qingyao Song

Jiangsu University, Zhenjiang, Jiangsu 212013, China

Correspondence should be addressed to Juan Yin; 1000004297@ujs.edu.cn

Received 1 July 2022; Accepted 20 August 2022; Published 9 September 2022

Academic Editor: Tao Cui

Copyright © 2022 Juan Yin and Qingyao Song. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Physical education is an important part of school's physical education and practical teaching activity. There are many restricting factors in physical education, such as the type of equipment and environmental conditions. The standardization of volleyball teaching technology has become the primary factor affecting teaching efficiency. Teachers demonstrate that the action is not standard and will lead students to learn that the technical action is not in place, and teachers can show students standardized technical action through multimedia technology, for example, through the video of athletes. The spatiotemporal nature presented in volleyball technology teaching affects students' understanding and mastering of technology, using network multimedia system-assisted volleyball training teaching, using the advantages of network multimedia, volleyball teaching students difficult to understand the technical action of the intuitive display, improve students' independent learning ability. This thesis studies the application of multimedia technology in the training and teaching of physical volleyball in colleges and universities. It analyzes the application of multimedia technology in the training and teaching of physical volleyball in colleges and universities, so as to provide useful references for the teaching reform of physical volleyball in colleges and universities.

1. Introduction

Multimedia has brought significant changes to the daily working life of human beings, and in order to meet the needs of educational modernization, the Ministry of Education promulgated the Outline of Basic Education Curriculum Reform, which proposes to vigorously promote the application of multimedia technology in teaching, to achieve changes in the presentation of teaching contents and teachers' teaching methods, and to play a rich nurturing environment. The teaching of physical education technology is then based on the expression of the teacher [1]. In order to achieve the goals taught at the beginning, teachers need to repeat the performance. The introduction of technology into physical education has a great role in enhancing sports volleyball practice and student learning [2].

Online multimedia skills teaching is a common method of teaching nowadays, which can reduce teachers' class time and make more of what they want to express presented in music

and sound. Some PPTs can be downloaded directly, but not all of them are ready. The professor's arrangement should be appropriate to the content taught [3]. The use of multimedia technology in volleyball is only taught to give students time to follow the intense and exciting international games, to learn the starting methods and tactics of different opponents through those examples and data so that students understand some regulations of volleyball and understand the necessary skills. In volleyball competitions, teachers can use multimedia technology to break down each step of the action. The use shows the advantages of technology in volleyball practice, which plays a good role in the proliferation of volleyball training. It is mainly reflected in the necessity of adapting to the progress of generations, spreading and increasing the amount of information for students.

Multimedia technology is slowly utilized through the teaching of knowledge, teaching of techniques and tactics, and other content. The knowledge of volleyball is taught very little, and the previous way of teaching is taught only by the

teacher, which does not allow students to develop an interest in volleyball [4]. Combined with multimedia teaching play courseware, screen conversion sound is conducive to students' interest in learning, to achieve a good teaching effect. In the teaching of volleyball theory, the knowledge, that is, difficult to explain in words can be presented visually through multimedia, for example, when explaining volleyball court, the volleyball court can be made into a multi effect picture file and displayed through multimedia, and each area of the court picture can be filled with different colors for audio and video description. The regularity of teacher performance is tied to the effectiveness of student learning. Teachers often show irregular movements to motivate students to learn. If technical activities are not available, teachers can use multimedia technology to present standardized technical activities for students. For example, the teacher can show video instructions of the operation, which can ensure the quality of teaching. The application of multimedia technology in volleyball teaching solves the previous drawbacks [5].

It is also extremely important to establish volleyball standards. A good volleyball standard is not only better for learning the sport but also useful for improving skills and is also the least harmful to your body.

In volleyball, there is a round-robin system, and the number of rounds and games in a round-robin match is calculated as one round after each team has participated in a match. When the number of teams participating in a match is odd, the number of rounds is equal to the number of teams. If 7 teams participate in the game, the number of rounds is 7: if the number of teams participating in the game is even, the number of rounds is equal to the number of teams minus 1. If 8 teams participate in the game, the number of rounds is $8 - 1 = 7$ (rounds). The number of games in a single-round tournament can be calculated as follows:

$$N = m * \frac{(m - 1)}{2}, \quad (1)$$

where N is the number of games and m is the number of teams.

In terms of the single-round robin system and the method of determining the ranking, each team will get 2 points for a win and 1 point for a loss, and the forfeit will cancel all the results of the competition. If two or more teams have equal points, the ranking will be decided by equation:

$$A/B = C(\text{value}). \quad (2)$$

The team with the highest C value will be ranked first. A : the total number of winning games, B : the total number of losing games.

If the C values are equal, the ranking is determined by equation:

$$X/Y = Z(\text{value}), \quad (3)$$

where X is the total number of points scored and Y is the total number of points lost.

If the Z -values of two teams are still equal, the ranking should be decided according to the victory or defeat between them. If three or more teams have equal Z -values, the ranking shall be determined by the number of net wins between them, as in equation:

$$D - E = F(\text{value}), \quad (4)$$

where D is the total number of winning games and E is the total number of losing games.

When it comes to the game, we have to talk about several forms of lineups, as shown in Figure 1.

Advantages: the front row can always keep a second passer and two attackers in each round, which makes it easy to organize the middle one and two and side one and two attacks, and the tactics are stable.

Disadvantage: the front row has relatively few attacking points and poor concealment.

Pros: it strengthens the attacking power of blocking and front row so that the whole team only needs to adapt to one-second passer, which is conducive to cooperation and unified command, and makes the tactics rich in changes [6].

Disadvantage: when the second passer takes the front row's turn, there are three rounds with only two attackers in the front row, and the attacking point is too exposed, which affects the attacking power of the front row.

In terms of the three-three equipment, as shown in Figure 2.

In each round, there are 1 or 2 attackers and the second passer, but the attack is not enough.

Multimedia computing is an advanced technology that has emerged in recent years. Volleyball has only two main parts: the basic techniques of passing, passing, pointing, serving, and blocking, and the various tactical attacks under the guise of fastball [7]. In a computer, textual explanations, video displays and animations, and even musical explanations and demonstrations of classical movements are needed to clearly depict the process, store these on the computer for use, and make them readily available for consultation and printing. Secondly, the scientific description, analysis, and management of the sport of volleyball, using its pedagogical tools to effectively improve the effectiveness and level of volleyball teaching [8].

2. State of the Art

First, the current situation of high school volleyball development in Changchun city is taken as the research object.

Teachers are the foundation of education, and the content and tasks of teaching must be accomplished with the help of teachers. The results in Figure 1 show that there is a general lack of professional volleyball teachers in elementary schools, resulting in a serious lack of high-level professional volleyball teachers in many developing schools. The development of the sport of volleyball is greatly limited. Of the 168 physical education teachers in the 21 schools surveyed, 16 (9.5%) were professional volleyball teachers and 152 (90.5%) were other professional teachers; 53 (31.5%) participated in volleyball practice (Figure 3); and 115 (68.5%)

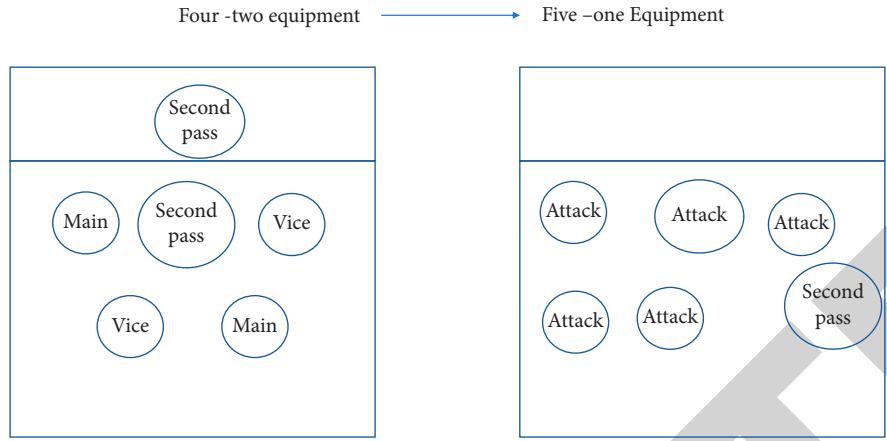


FIGURE 1: Four-two equipment and five-one equipment.

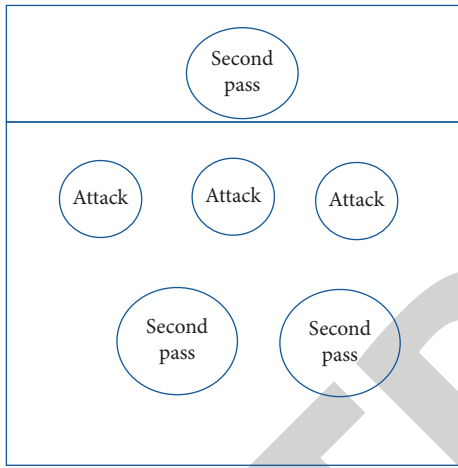


FIGURE 2: Three-three equipment.

did not participate in training, which shows that volleyball teachers in Changchun middle schools are truly professionally trained. Most were independent or ad hoc formations, usually with a low level of activity. Under such circumstances, it is difficult to guarantee the quality of teaching and training, especially for students, who love volleyball and want to further improve their skills and tactics at a certain technical level, which teachers nowadays often cannot do. So all the work meets their needs, thus reducing students' motivation to learn [9].

As can be seen from the survey results, as shown in Figure 4, as far as the actual situation of each school is concerned, very few schools are able to conduct volleyball classes, and even if they do, the teaching is very incomplete and has a very lightweight in physical education [10].

Volleyball techniques are divided into preparatory posture and movement, serving, matting, passing, dunking, blocking, and other techniques; the teaching process of the entire buckle is as follows Figure 5 it can be seen that all volleyball schools have passing, matting, and serving as the main teaching content, in order to help students improve their physical quality.

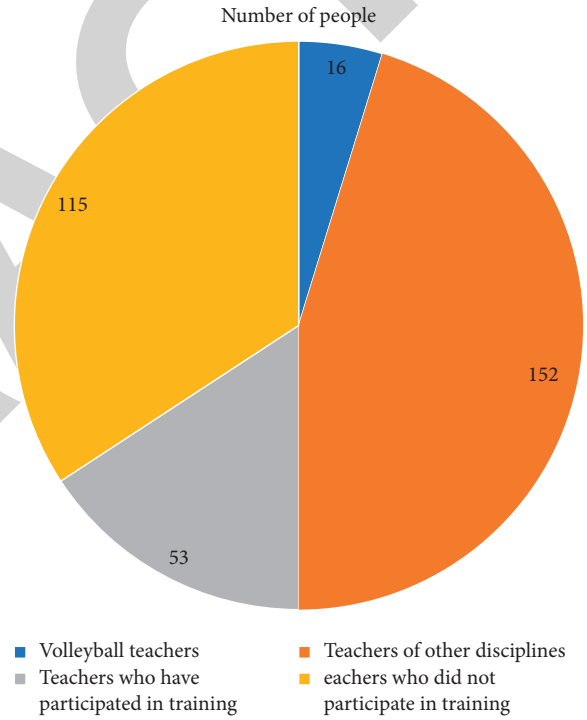


FIGURE 3: 21 high school sports teachers in Changchun city.

After-school volleyball activities include various student-initiated volleyball activities and various volleyball activities organized with the participation of the school (as shown in Figure 6).

Among the 21 high schools surveyed, 12 schools (57.1%) participated in municipal competitions, 5 schools (23.8%) participated in provincial competitions, and only 1 school (4.8%) participated in national competitions, see Figure 7. It is clear that from an external competitive standpoint, Evergreen High School volleyball is not nearly enough. Competition is an important factor in promoting sports, and tournaments greatly foster student interest. We hope that the authorities in Changchun will pay great attention to it. As more and more games are played, and

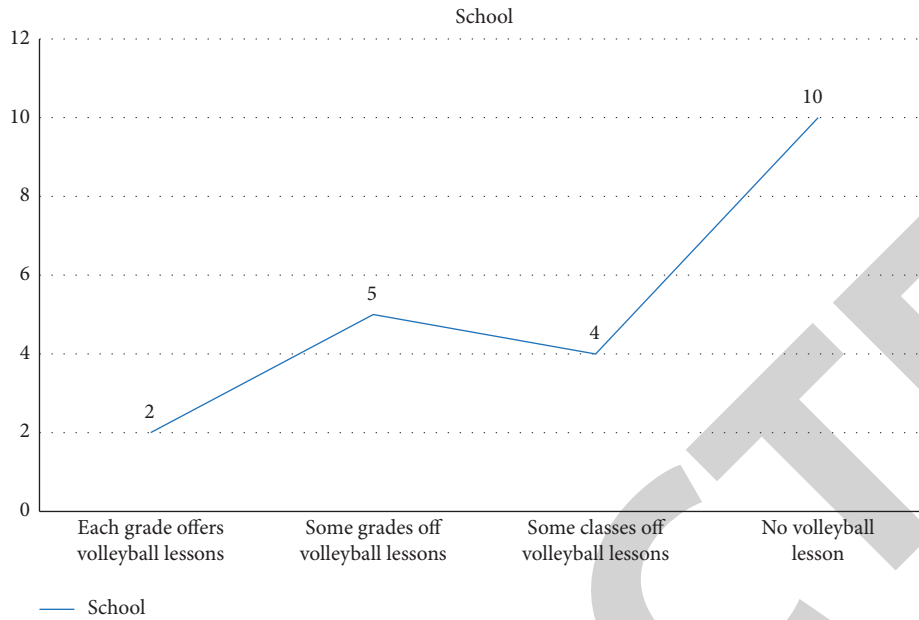


FIGURE 4: Changchun high school opened the basic situation of volleyball lessons.

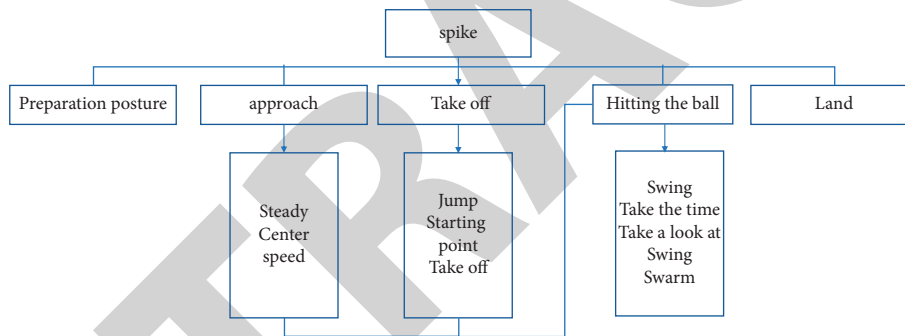


FIGURE 5: Basic factor relationship diagram of the technical action structure.

more and more people pay attention, then the focus of the school will be skewed and volleyball will be taken seriously.

The attitude of school leaders toward volleyball and the organization of volleyball tournaments by the competent authorities were analyzed in a graph (Figure 8). Tournaments develop a sense of honor in children, and more tournaments will result in more honor, which is necessary to increase interest in volleyball.

In terms of equipment, 57.2% of schools have less than 10 volleyballs, 19.0% have between 10 and 20 volleyballs, and only 9.5% have more than 40 volleyballs; we found in some schools that the volleyballs used by students are broken and have lost their skins, and there are few intact volleyballs left. It is clear that most of the volleyball equipment at Evergreen High School does not meet the teaching needs. With the significant growth of volleyball in schools, the demand for volleyball equipment will increase. The difficulty of meeting the needs of ordinary schools for activities other than physical education has severely hindered the development of volleyball courts for students. The development of school volleyball greatly limits students' interest in the sport as shown in Table 1.

Volleyball for beginners must have a learning and adaptation process, especially the learning and comprehensive application of several basic techniques of serving, passing, pad, buckling, and blocking. Table 2 shows that the mastery of the basic technique of snapping the ball is not as good as it should be, let alone proficient in playing volleyball.

It plays an important function of orientation, initiation, regulation, reinforcement, and maintenance of physical learning and physical exercise behavior, and has an important influence on the effect of physical activity. For this reason, after conducting a survey, the results are shown in Table 3 (with multiple motivations).

Through the survey of physical education teachers in Changchun High School, leaders attach importance to the degree of attention, teachers, influential competitions, teachers' training opportunities, venue equipment, etc., are the main factors of the high school in Changchun High School at this stage. The questionnaire survey found that the main factors affecting high school students to perform volleyball exercises are activity time, venue equipment, technical guidance, etc. (see Table 4 (more than one)).

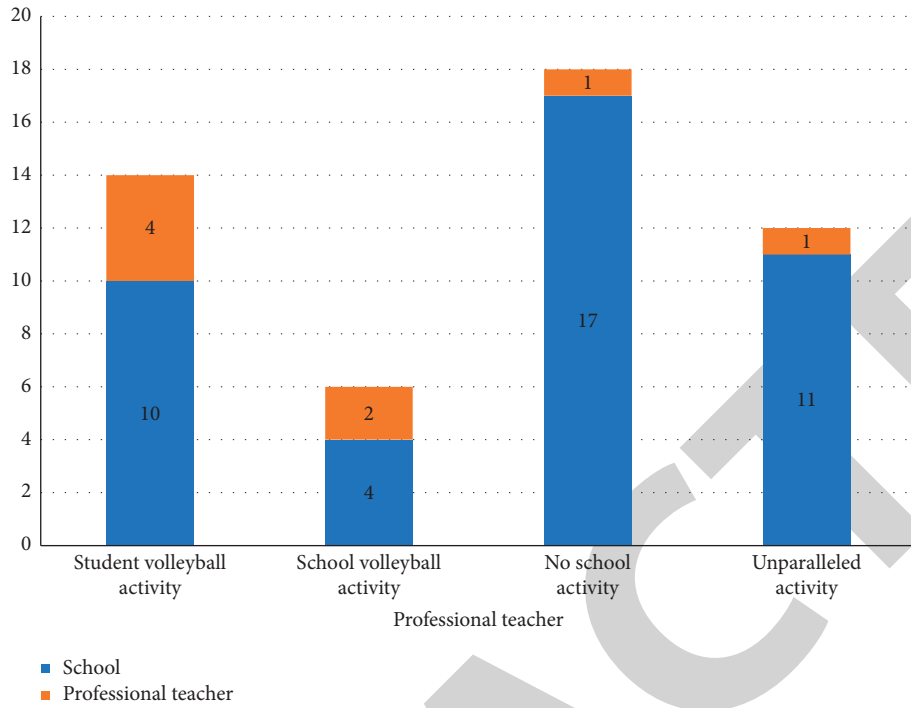


FIGURE 6: Volleyball activity survey.

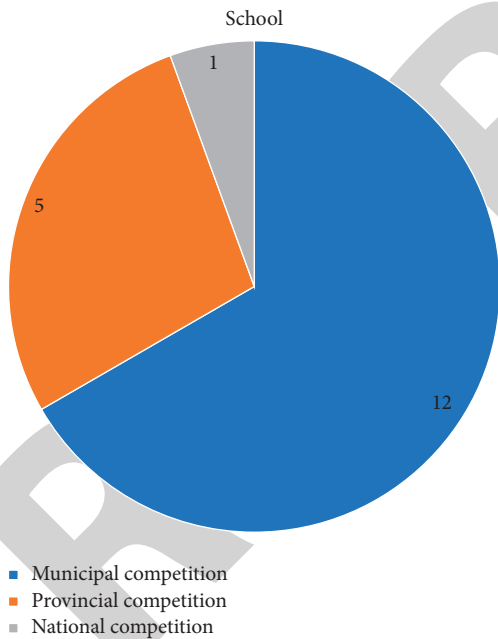


FIGURE 7: School participation in off-campus competitions.

- (1) Multimedia technology can strengthen students' volleyball fundamentals. Due to the high academic pressure of high school students, most of them do not pay much attention to sports, which also weakens their physical fitness and motor coordination. It is difficult to adapt to large, high-intensity exercise programs [11]. Therefore, in high school volleyball training, teachers should take a step-by-step approach according to the actual situation of

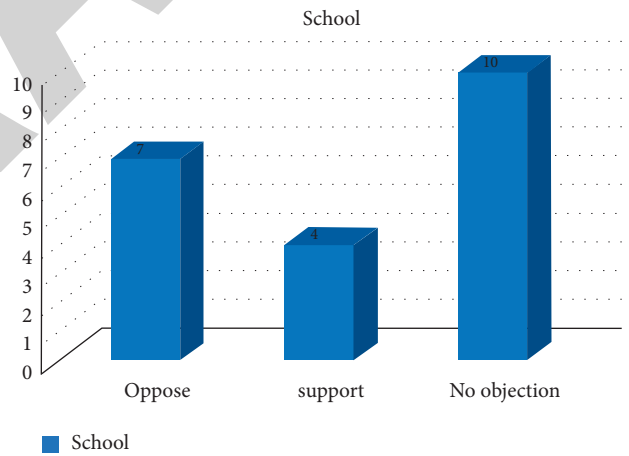


FIGURE 8: Survey of volleyball attitudes of schools in the competent department.

the students by first explaining the theoretical knowledge of volleyball to the students and then training them in the corresponding motor skills. This provides more opportunities for students to update and adapt while saving training time. When teaching theoretical knowledge, teachers can appropriately use multimedia technology to make abstract theoretical knowledge more visual and concrete to help students better understand and master the theoretical knowledge [12]. For example, when teaching front-end theoretical information, teachers can use multimedia equipment to enhance teaching. The purpose of this lesson is to let students understand and master the position of the point of

TABLE 1: Existing volleyball courts and number of volleyballs in 21 high schools in Changchun.

School (s)	Site (pcs)	Proportion (%)	School (s)	Volleyball (pcs)	Proportion (%)
11	0	52.4	12	Less than 10	57.2
5	1	23.8	4	10–20	19.0
2	2	9.5	2	20–30	9.5
2	3	9.5	1	30–40	4.8
1	More than 3	4.8	2	More than 40	9.5

TABLE 2: Students' mastery of volleyball techniques.

Content	Male (pcs)	Percentage (%)	Female (pcs)	Percentage (%)
Roughly mastered the passing and cushioning technique	132	54.3	103	45.4
Proficient in passing and cushioning technique	38	15.6	28	12.3
Roughly mastered the snapping technique	27	11.1	13	5.7
Proficient in snapping technique	18	7.4	6	2.6
More proficient in using various techniques for the game	47	19.3	36	15.9

TABLE 3: Survey on students' motivation to participate in volleyball activities (there is more than one motive).

Content	Indicator 1 (male)	Percentage (%)	Indicator 2 (female)	Percentage (%)
Promote physical health	221	90.9	177	78.0
Improve physical function	152	62.6	112	49.3
Get in good shape	113	46.5	107	47.1
Recreation	103	42.4	96	42.3
Regulate emotions	112	46.1	89	39.2
Enrich life	121	49.8	89	39.2
Improving sports skills	140	57.6	84	37.0

TABLE 4: The main factor affecting high school students for volleyball exercise (more than one).

Survey content	Teacher	Percentage (%)	Survey content	Students	Percentage (%)
Leader attaches great importance	118	70.2	No time	352	74.9
Faculty	113	67.3	No venue equipment and facilities	258	54.9
Influential competition	96	57.1	No technical guidance	205	43.6
Teacher training	84	50.0	No activity habits	142	30.2
Venue	68	40.5	No sports atmosphere	138	29.4
Examination system	56	33.3	No exercise partner	132	28.1
School funds are tight	28	16.7	Inertia	89	18.9

impact correctly. Therefore, during the teaching process, the teacher can use multimedia equipment to show the students a picture of a ball on the leg and let them observe the picture carefully and pay attention to the position of the pillow. The teacher then explains in detail how to hit the ball with the arm and teaches students the skill of catching the ball when it bounces and lands in the correct position. Once students have learned this part of the theory, the teacher can explain where to strike the ball. Students can only master the correct form of the punch to ensure the efficiency of the punch and avoid injuries during practice. After the above-mentioned theory learning, students basically mastered the theory on the mat. Teachers can take advantage of this situation and play cartoon videos to students through multimedia equipment to guide them to follow the whole forging process so that students can deepen the theoretical knowledge they have learned in practice and their understanding of

the theoretical knowledge. At the same time, it can give students the opportunity to better understand the beauty of volleyball, thus stimulating their interest in playing volleyball.

- (2) An important part of volleyball is the use of multimedia equipment to improve students' volleyball tactics. Therefore, when teaching high school volleyball drills, teachers should enhance the practice of volleyball tactics for their students. By using multimedia technology in teaching volleyball tactics, you can watch and learn tactics through video materials related to volleyball games, making tactics clearer and more intuitive [13]. At the same time, teachers can also use the demonstration function of multimedia equipment to introduce volleyball tactics and coordination to help students master volleyball tactics and improve their volleyball skills. For example, when teaching the tactics of one and two attacks, students do not have practical experience, so if they only use theory, such

tactics will not appear in their minds, so the teaching effect is very good but unable to connect. To address this phenomenon, teachers can use multimedia teaching equipment to help students understand and master this tactical method more intuitively. Schools that qualify can allow school volleyball teams to demonstrate tactics and shoot videos. In schools that do not, teachers can collect tactical videos online and turn them into educational materials. In the classroom, teachers can use multimedia devices to introduce the game to students while explaining the game to them, such as player positions and attack route variations. The main feature is that the teacher can use the media device to perform functions such as pause, replay, and rewind to allow students to better observe and learn strategies and improve their understanding and mastery of strategies [14].

- (3) Innovative techniques and tactics with the help of multimedia equipment volleyball is a sport with dynamic continuity, and the techniques and tactics in volleyball are not set in stone. Due to the different playing levels of teammates and the attacking methods and tactics of opponents during the game, volleyball players need to improvise, update and innovate their techniques and tactics in time so as to enhance the possibility of winning. Although volleyball training in high school is not comparable to professional volleyball training, and the physical quality and coping ability of high school students are not comparable to those of professional volleyball players, the innovative teaching of volleyball techniques and tactics in high school sports volleyball is very beneficial to the improvement of students' physical quality and the development of their innovative ability. Therefore, in high school sports volleyball training teaching, teachers should encourage students to participate more in volleyball tactics training and to innovate tactical strategies by means of free combinations and splicing of volleyball movements. In order to enhance students' experience of different tactics, teachers can use multimedia equipment to play videos of volleyball games for students. For example, teachers can show students the games of China against the Netherlands, Italy, Serbia, and other countries in the 2018 Women's Volleyball World Championships, and guide students to analyze the success and failure of the tactics adopted by China's women's volleyball team against different countries, and find out the strengths and weaknesses of the tactics adopted. The teacher then encourages the students to use the theoretical knowledge they have learned to jointly simulate and develop a set of tactics to counteract them and start training. Through this combination of theory and practice, students will be able to improve their knowledge of volleyball.

3. Methodology

3.1. Establishing Volleyball Movement Standards

- (1) Collecting information: find relevant books, magazines, and materials, and summarize and organize the basic movements of volleyball [15].
- (2) Expert opinion: the collected data were analyzed and studied by sports experts to determine the movement standards of volleyball techniques.
- (3) Image and photo maintenance: images were cut into video clip files and sorting of these files; graphic transformation operations such as rotation and translation were performed on the moving parts of the images to make the movements conform to the standards.

3.2. Preprocessing Work

- (1) Image processing: collect the classic game clips of excellent teams and athletes in the world tournament, and use them to show the action standards; collect the nonstandard action clips in volleyball teaching, and use them to demonstrate the action that needs to be corrected; and collect the pictures and scan them into a standard picture format [16].
- (2) Edit text: organize various action points of the standard, instructions, easy-to-make mistakes, and correction methods, make the text material more accurate and concise.
- (3) Animation production: design the character shape and design key frames according to the action picture. In terms of the amount of data in the image, the calculation is shown in equation:

$$\begin{aligned} \text{The} \cdot \text{data} \cdot \text{volume} \cdot \text{of} \cdot \text{image} &= \text{image} \cdot \text{resolution} \\ & * \cdot \text{image} \cdot \text{depth} \% 8. \end{aligned} \quad (5)$$

- (4) Audio production: configure the music for the volleyball action to form an audio file.

3.3. Establish Multimedia Network Database. Before building the database, we need to analyze the data (media files and text files) requirements, create a conceptual model, and then convert it into a system data model. The process of establishing a database is shown in Figure 9.

We need to first clarify what we need through requirements analysis, then conceptual structure design, logical structure design, and physical structure design, to build out the basic architecture of our database, all done after the implementation of the database, and finally this operation and routine maintenance.

Establishment steps include the following:

- (1) Define the structure of the database: the volleyball event media database system needs to have basic and control data.

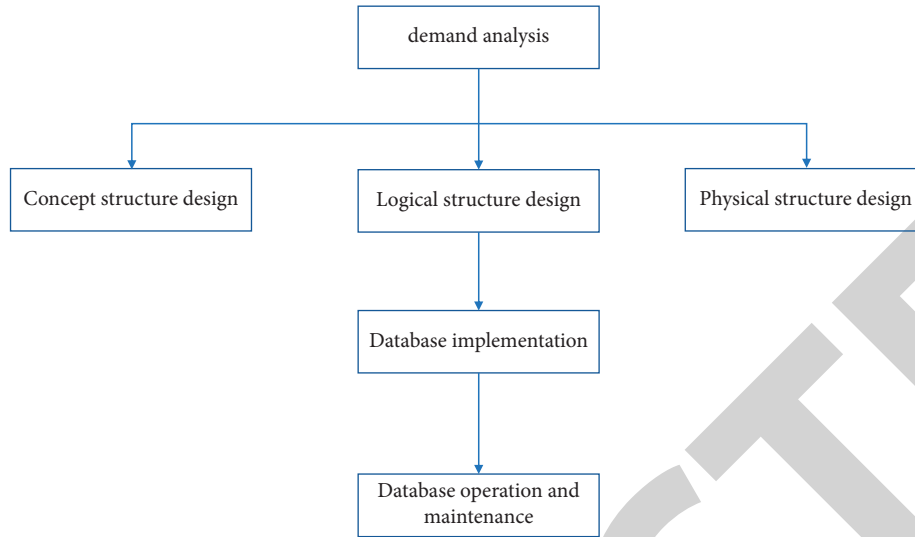


FIGURE 9: Establish six steps for databases.

- (2) Create a data dictionary: the technical indexes of volleyball by category, name, and order of various gymnastic movements unified code, stored in the data dictionary, and organized into the database according to the data table structure requirements [17].
- (3) Multimedia data entry [18]: the system has three innovations: first, it does not perform any user environment maintenance; second, in addition to the basic data (data describing the functions), control data are added to the database. The control data describe the main data structure and functional structure of the system, the control program operation, and the positioning control data. Information about fitness technology or system functionality can be easily added or removed from the system containing control information, resulting in a highly transparent and customizable system; third, media information is organized using links. This optimizes the organization of data, increases the flexibility of the system, and makes system queries more efficient.

For multimedia applications, the data transfer speed is as in equation:

$$V = \text{HZ} * \text{Bit} * n, \quad (6)$$

where V is the data transfer speed, HZ is the sampling frequency, bit is the number of quantization bits, and n is the number of channels.

The audio compression data ratio is solved as in equation:

$$B = \frac{m}{n}, \quad (7)$$

where B is the audio compression data ratio, m is the amount of compressed audio data, and n is the amount of audio data before compression.

Multimedia audio calculation formula as shown in equation:

$$\text{Data volume} = \text{seconds (audio time)} * \text{number of channels (mono for 1, dual channels for (2))} * \text{number of sampling bits} * \text{sampling frequency (HZ)} \% 8. \quad (8)$$

3.4. *System Design.* The most important thing is to determine the programming model.

- (1) Programming approach: the system programming emphasizes three features: first, it adopts a top-down modular design approach, which is easy to maintain and expand the system; second, it uses object-oriented technology design, which is easy for users to understand and use; third, it uses data visualization techniques to design the program, which makes the data more independent and the system more flexible [19].
- (2) Computer languages used: the UI design uses ASP, multimedia data processing, and SQL Server 2000 database support, and the system works directly on the server, which can be used in multimedia classrooms and classrooms. The computer classroom is flexible to respond to the needs of teachers and students.

3.5. *System Functions.* User feedback: user feedback forms are provided to collect user data and FTP file servers for different upload services, and different data files can be sent to understand user feedback [20].

Data maintenance: mainly updates the media files. System maintenance is server maintenance. The user can use the system by simply opening the browser and no customer service is required.

Help: the system is designed with a standard Windows help function that provides system description and operation, as well as sample queries and navigation methods [21].

4. Result, Analysis, and Discussion

Volleyball technical training methods can be summarized as service technical training methods to improve accuracy, stability, aggressiveness, and combat efficiency as pad training methods techniques (individual training, collective cooperation in catching the ball, dunk training), training methods (general), passport, secondary education methods, and technical methods of dunking training (step dunking, techniques).

With its friendly interface, simple human-computer interaction, and rich database information, users can find the required training methods quickly by database query or classification query, which improves the efficiency of lesson preparation and indirectly improves the efficiency and quality of volleyball technical training [21].

Also, the use of this technique with our daily volleyball, or not only volleyball but also other sports, such as basketball, badminton, table tennis, rugby, soccer, tennis, and even running, contains great benefits for our daily learning of how to exercise, which is a great help. For example, in learning to run, we can use this technique to better learn the running posture and running breathing pattern, simulating the kind of breathing, the amplitude of the swing, and the starting posture. There is a better specification, which can not only help us to learn easily and increase certain efficiency but also reduce the pressure on our body due to incorrect posture, which can damage our body. We hope that with the development of technology, we can do better and better in this area, and let our learning style, or the way the teacher teaches tends to diversify, in favor of our growth and become more powerful.

5. Conclusion

The introduction of multimedia technology has had a positive impact on teaching and will have an impact on other teaching methods as well. The reasonable use of multimedia technology in high school sports volleyball training can make the training methods more intuitive and feasible, encourage students to better understand and master the skills and requirements of volleyball, and further improve their volleyball skills. Therefore, in high school volleyball training and teaching, teachers should make reasonable use of multimedia technology to support teaching according to the actual situation of students, increase the effect of education for volleyball coaches, and promote the development of volleyball teaching in high school in China.

Applying basic stability training to youth sports routines can be very helpful in many ways. It not only helps to improve athletic and technical performance but also reduces unnecessary energy expenditure and sports injuries in training and sports competitions for young athletes. Therefore, coaches should actively train young athletic students in basic stability training, accumulate useful experience in basic stability training, and build a solid foundation for professional growth as young athletes through basic stability training.

In summary, we have great expectations for the future of our teaching methods, regardless of the previous teaching methods, our world is growing after all, whether it is

technology or something else, for teaching, teaching models, etc., are constantly improving, we hope that this technology can be used not only in this area but also to benefit other areas. We are looking forward to the future, maybe one day, we can use technology to realize the interaction of the unreal world, that is, we can not only play volleyball and learn volleyball on the court, but also learn in the unreal world, so that there will be no more loss of body, and we can have unlimited strength to learn, and we can even use the time to sleep. Therefore, the use of network multimedia to build a database is a great aid to our teaching, but also a big step forward in our teaching breakthrough.

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

This work was supported by Jiangsu University.

References

- [1] Y. Wang, "Exploring innovation of college volleyball teaching under the vision of new media," *Industry and Technology Forum*, vol. 21, no. 09, pp. 175-176, 2022.
- [2] H. Zhang, "The new idea of volleyball teaching in colleges and universities under the concept of Sunshine Sports," *Journal of European Economy*, vol. 2021, pp. 103-104, 2019.
- [3] Y. Zhang and W. Hu, "Cultivation of students' tactical awareness in high school volleyball teaching," *Sports Vision*, no. 22, pp. 38-39, 2021.
- [4] S. Chen, "Research on the application of multimedia technology in sports volleyball training," *Contemporary Sports Science and Technology*, vol. 10, no. 29, pp. 89-91, 2020.
- [5] L. Zhao, "The construction of volleyball course content in college under multimedia video practice teaching mode," *Liberal arts enthusiasts (education teaching)*, no. 04, pp. 10-12, 2020.
- [6] T. Wu and G. Chassang, "Chapter 6. French and Chinese regulatory approaches to end-of-life and euthanasia," *Journal international de bioéthique et d'éthique des sciences*, vol. 31, no. 1, pp. 63-83, 2020.
- [7] Li Mei, "The application of multimedia technology in college volleyball teaching," *Digital World*, no. 03, pp. 160-161, 2020.
- [8] Li Yan and J. Han, "The high school volleyball teaching, the cultivation and training of the two-handed hands," *Journal of European Economy*, vol. 2021, pp. 24-25, 2018.
- [9] N. Du, "Research on the construction of digital resources for volleyball network teaching," *Contemporary Sports Science and Technology*, vol. 9, no. 35, pp. 246-248, 2019.
- [10] B. Xu and L. Changqin, "Practical dimension and optimization strategy of improving the teaching quality of political theory courses in colleges and universities," *Region - Educational Research and Reviews*, vol. 3, no. 3, p. 21, 2021.
- [11] Z. Nagy and A. E. Müller, "A study on word association when teaching the theoretical rules of volleyball in physical education classes," *STADIUM - Hungarian Journal of Sport Sciences*, vol. 1, no. 1, 2018.

Retraction

Retracted: A Deep Learning-Based Assisted Teaching System for Oral English

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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] H. Li and X. Liu, "A Deep Learning-Based Assisted Teaching System for Oral English," *Security and Communication Networks*, vol. 2022, Article ID 1882662, 10 pages, 2022.

Research Article

A Deep Learning-Based Assisted Teaching System for Oral English

Haibo Li¹ and Xue Liu² 

¹Chuxiong Medical College, Chuxiong, Yunnan 675005, China

²Foreign Languages and Tourism Department, Hebei Petroleum University of Technology, Chengde 067000, China

Correspondence should be addressed to Xue Liu; cdpc_lx1@cdpc.edu.cn

Received 5 July 2022; Revised 2 August 2022; Accepted 16 August 2022; Published 9 September 2022

Academic Editor: Tao Cui

Copyright © 2022 Haibo Li and Xue Liu. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

The progress of global economic integration has forced English learners to have an urgent need to improve their oral English. College students' oral English ability is currently the worst of the four abilities of listening, speaking, reading, and writing. The main reasons are internal and external. The internal reason is that the pronunciation characteristics of Chinese students are different from those of English. The external cause is that the practice environment and tools of oral English are not ideal, which affects the improvement of learners' oral English. This study proposes using a deep learning algorithm (DLA) English in the evaluation of oral English quality to improve learners' oral English level. The quality of oral English can be comprehensively evaluated in terms of pitch, speed of sound, and rhythm. The standard of pronunciation is the foundation of oral English and is the most critical factor. In many DLAs, the input unit of DNN at a certain moment and its upper and lower moment input units have no relationship and are independent of each other, and the timing dependencies of adjacent units are not fully considered. The results are generally not very good on speech recognition tasks. This study proposes a time-delay neural network (TDNN) and a long short-term memory (LSTM) network to calculate the posterior probability of the model state to model context-dependent features in order to solve this problem. The fusion model TDNN-LSTM is applied in the English spoken pronunciation recognition task. To compare the accuracy of oral English pronunciation, several classic DLAs are introduced. The experimental results show that the method described in this study has a number of advantages. Although the performance improvement of this method in terms of recognition accuracy is not large, a certain degree of improvement is also very important for the oral English teaching assistant system.

1. Introduction

With the expansion of the global economy, economic and cultural exchanges between countries are becoming more common. At present, the international communication is still in English. Therefore, learning English is very important. Among the abilities of listening, speaking, reading, and writing in English, reading and writing have always been the strengths of Chinese students, but listening and speaking are relatively weak. Among them, speaking ability is the most difficult for the majority of students to overcome. The cultivation of oral expression ability plays a vital role in English teaching. If you learn any language, if you cannot speak it, you will not be able to achieve the expected communication purpose. However, the level of oral English of college students is generally low, and even many students

cannot express in English, and they have a sense of fear of oral English. There are three main reasons why students' oral English is generally poor. First, there is no environment for practicing oral English. Many schools do not have professional and large-scale oral English communication institutions, and students have no place and object for practice. Second, Chinese people are generally introverted, and most students think that practicing oral English in public places will be unusual or feel ashamed to say it wrong. The third is the environment where English is not used. In China, English is not required in other places, except for some foreign companies that use English. Fourth, China has a large population studying English, and the number of professional oral English teaching staff is seriously insufficient. The situation of students' oral English learning cannot be quantitatively evaluated. The above is the fundamental reason

why the teaching effect of oral English has not been improved. In such a big environment, teachers need to improve students' oral English, which has become the focus and difficulty in English teaching. For the problems related to the general environment in oral English teaching, ordinary teachers have no ability to change, but for the fourth problem, teachers can use some auxiliary tools for oral English teaching to improve the teaching effect [1–3]. English speaking aids usually have the following functions. The first function is to score the oral audio uploaded by the learners. Students can clearly understand their speaking level according to the score. The second function is to correct mistakes in pronunciation. The system is able to point out the speaker's mistakes in the audio and tell you the correct pronunciation of a wrong word. The third function is to generate oral language learning reports for learners to understand and analyze their oral language learning status as a whole.

The birth of the English oral assistant system has improved the oral level of oral learners to a certain extent. Many scholars have also dedicated themselves to the design and development of an oral English-assisted teaching system. Reference [4] proposes a robot-assisted learner to practice oral English for Japanese adults. The characteristic of this study is that it is mainly aimed at the adult population. The experimental results show that the robot developed in this study can help adults improve their spoken English. Reference [5] proposes a human-machine dialogue system to increase learners' interest and accuracy in oral English practice. Reference [6] introduces a deep belief network to recognize the pronunciation of spoken language and judge whether it is correct or not. Reference [7] analyzes the difficulties existing in oral English teaching through data analysis tools and gives corresponding solutions. Reference [8] proposes an intelligent technology for students with visual impairment to guide their English learning. Reference [9] used a supervised machine learning method to evaluate the quality of students' oral English, including pronunciation accuracy and fluency. Reference [10] uses a hierarchical classification method to analyze the pronunciation categories of oral English, so as to judge whether the speaker's spoken language is standard. Reference [11] applies machine learning to the assessment of oral English proficiency levels. Experiments show that tone and intonation are key factors affecting its evaluation. The essence of oral English pronunciation recognition based on machine learning [12–14] is to classify and recognize each word in the input audio. The essence of oral English pronunciation recognition based on deep learning [15–17] is the same. The difference is that the process is different. DLAs incorporate both feature extraction of the data and final classification.

The above studies used data analysis tools, machine learning, and DLAs to identify oral English, including the pronunciation of spoken language and whether the intonation is correct and fluent. By identifying the results and guiding oral learners on how to pronounce correctly, the quality of oral English teaching can be improved. This idea of improving oral English teaching is correct. The premise is that it is necessary to develop a method with high

recognition accuracy and fast recognition speed. The problem with machine learning-based pronunciation recognition methods is that the final recognition results are generally not ideal, and the recognition results are easily affected by noise, feature extraction methods, and final classifiers. The problem with deep learning-based pronunciation recognition is that the model training event is too long, making it difficult to meet the needs of real-time recognition. Moreover, most deep models need to adjust multiple parameters, so the model is easily affected by parameters, resulting in unstable final results. Aiming at these problems, this study proposes an English speaking assisted teaching system based on DLA. The classic DLAs include convolutional neural network (CNN) [18], deep neural network (DNN) [19], and LSTM [20]. In this study, to improve the pronunciation accuracy of the model for oral English, a hybrid deep neural network is used. There is no relationship between the input unit of DNN at a certain time and its upper and lower time input units, and they are independent of each other. The timing dependencies of adjacent units are not fully considered, so the results of the fully connected feedforward DNN on speech recognition tasks are generally average. Neither was good. To solve this problem, this study first introduces TDNN and LSTM to calculate the posterior probability of the model state to model the context-dependent features. It will be applied to the English spoken pronunciation recognition task.

2. Relevant Knowledge

2.1. The Teaching System Assists the Learning Process of Oral English. Using machines to help people improve their oral English is the purpose of the auxiliary teaching system. The teaching system assists the oral English learning process as shown in Figure 1. A complete auxiliary teaching system mainly includes language input, language practice, and result output.

In the language input stage, both standard and test data are entered. Correct pronunciation, standard speaking rate, and rhythm are examples of standard data. Different standard data are put for different learners and situations. The test data are the user's oral English audio data. During the language practice phase, the assistance system acts as a learning buddy, conversing in English with the learner. The auxiliary system can be configured to reflect the learner's preferred English style and play a role in the task situation. This method can pique the learner's interest in communicating in English. The system can perform a variety of functions during the language practice phase. According to the user's identity, practice topics of different topics are imported. Exchanges on topics are practiced. Feedback adjustments are made based on the results of the communication. At this stage, the user can not only actively communicate with the system but also the system feedback and communicate the results. The system can also actively push the content that users need. The active push function is mainly determined according to the personal identity and hobbies and other tags set by the user. In the language output stage, the system provides evaluation feedback tools for

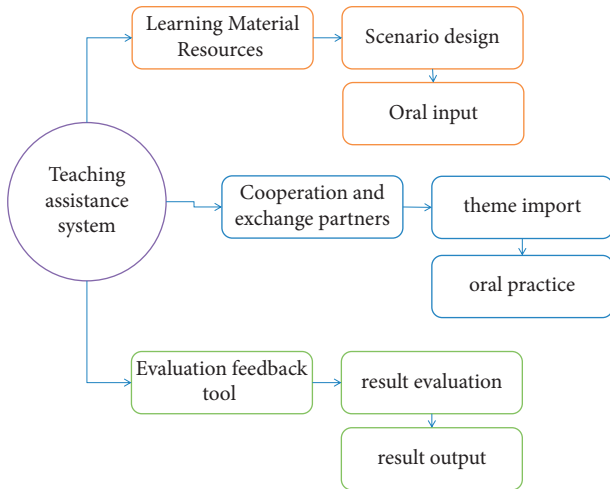


FIGURE 1: Teaching system to assist English learning process.

result evaluation. According to the evaluation results, users can strengthen the weak items. After a period of study, the learner can communicate with the auxiliary system again to assess whether their oral proficiency has reached the goal. If you do not reach your goal, keep learning. If the goal has been achieved, the assistance system also completes the task satisfactorily.

2.2. Auxiliary Oral English Teaching Design. Figure 2 depicts the design process for auxiliary oral English teaching. The design of auxiliary speaking instruction must consider three factors: teaching task analysis, teaching process, and teaching evaluation and reflection. Teaching task analysis mainly includes teaching objectives and teaching task analysis. Before the specific implementation of the teaching process, it is also necessary to understand the learner's situation, so there should also be participant analysis. The teaching process consists primarily of designing learning situations, resource tools, and learning strategies. After the learning process, it needs to be strengthened and consolidated to form a result evaluation. The evaluation link here also needs to use the assistance of the teaching system. The teaching process can be optimized through the assistance system. Finally, a summative evaluation is formed, and teaching reflection is carried out.

2.3. Oral English Assessment Based on Speech Recognition. Speech recognition is a technique for converting speech signals into words [21]. For a long time, the basic speech recognition framework depicted in Figure 3 has been the most traditional framework in the field of speech recognition, that is, a speech recognition system composed of acoustic models, pronunciation dictionaries, and language models. Audio input, feature extraction, an acoustic model, a pronunciation dictionary, and a language model are the main components of the traditional speech recognition framework. Mel-scale frequency cepstral coefficients (MFCCs) [22], perceptual linear predictive (PLP) [23], and other feature extraction methods for audio data are

commonly used. After feature extraction, the audio data are fed into the trained admission model for scoring. The scoring result, pronunciation dictionary, and language model together form a decoding network and finally output the speech recognition result.

3. A Method for Identifying the Quality of Oral English

3.1. Time-Delay Neural Network. Many DLAs are appropriate for processing continuous language data. This study employs the time-delay neural network (TDNN) [24]. When TDNN is used instead of traditional feedforward neural networks, the input of each hidden layer is increased. The input of each hidden layer not only keeps up with the output of the previous layer at the current moment but also the output of several moments before and after is combined into the current input. TDNN is a context-sensitive model that is designed to retrieve more historical information from the previous layer at the same time. DNN cannot model longer context temporal information and TDNN. The network is multilayered, with each layer having the ability to abstract features. It has the ability to express the temporal relationship between speech features. The learning process does not necessitate exact temporal placement of the learned labels. The amount of computation is reduced by sharing weights. Figure 4 depicts the TDNN structure.

The node corresponding to a specific moment in the hidden layer, as well as all the nodes corresponding to the time span before and after it, forms the basic unit of TDNN, which is known as time-delay neural network (TDN). Assume that TDN has a time span of T and that the node has N inputs $(x_1(t), x_2(t), \dots, x_N(t))$ at time t . The first T moments of each input $x_i(t)$ are input $x_i(t-n)$, $n = 1, 2, \dots, T$. The weight is $(w_{i1}, w_{i2}, \dots, w_{iT})$, and the calculation formula of the neuron output value $h(t)$ is as follows:

$$h(t) = f \left(\sum_{i=1}^N \left[\sum_{n=1}^T w_{in} \cdot x_i(t-n) + b_i \right] \right), \quad (1)$$

where $f(\cdot)$ is the activation function and b_i is the bias coefficient.

3.2. Long Short-Term Memory Networks. On time-dependent problems, recurrent neural network (RNN) [25] performs well. RNN remembers the current output data and adds it to the next input data. It is to add self-loop feedback information to each neuron in the hidden layer in the time domain; that is, the hidden layer's input contains information from the input layer and information from the hidden layer at the previous moment. As a result, RNN can highlight the strong modeling ability of time series-related information tasks more effectively. Figure 5 depicts the RNN structure.

Timing is represented by $t-1$, t , and $t+1$ in the diagram. x represents the input data. The memory at time t is represented by s_t . W represents the input's weight. U represents the current weight of the input parameter. V denotes the

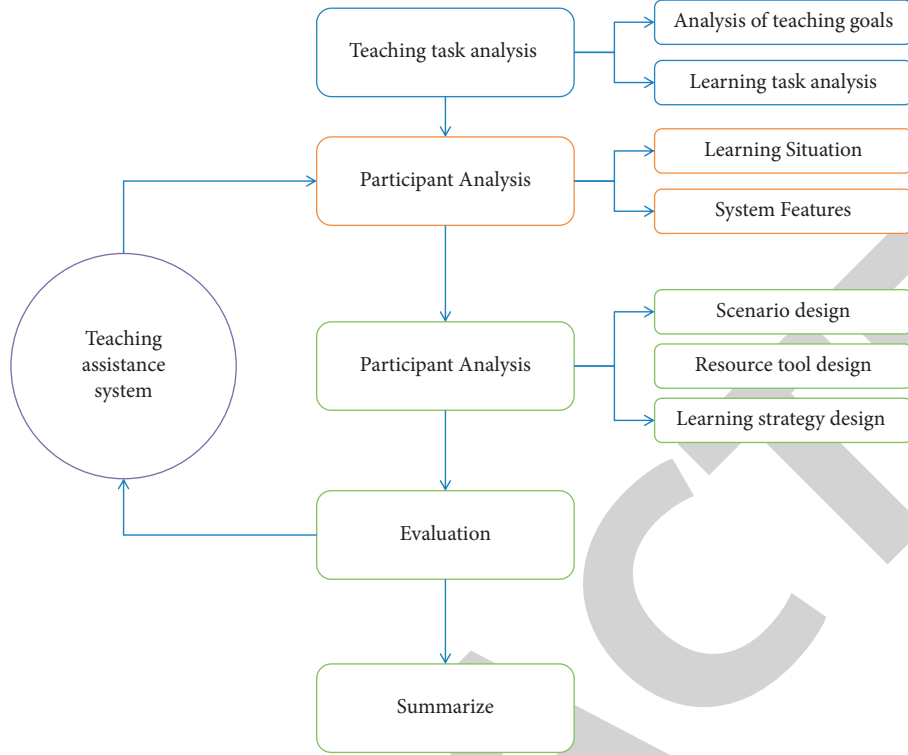


FIGURE 2: Design process for auxiliary oral English instruction.

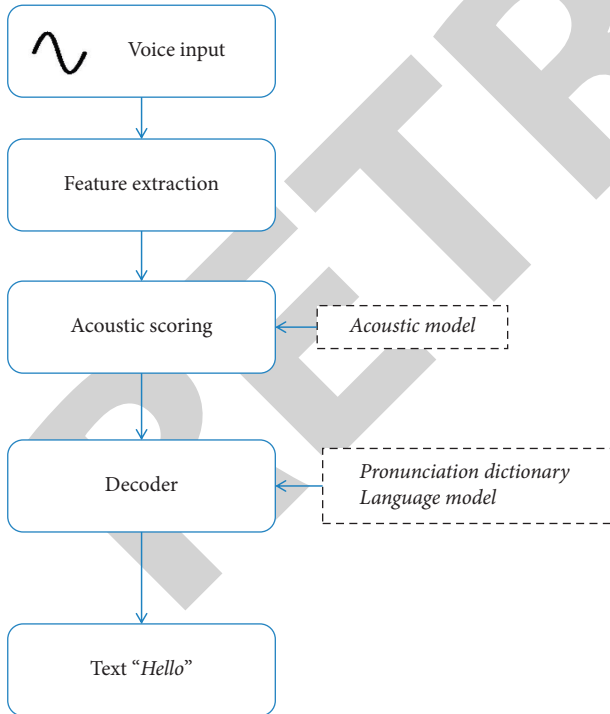


FIGURE 3: Classic framework of speech recognition.

output parameter's weight. At time $t=1$, input s_0 is set to 0. W , U , and V values are initialized at random. Equation (2) calculates the h_1 value, s_1 value, and o_1 value.

$$h_1 = Ux_1 + Ws_0, \quad (2)$$

$$s_1 = f(h_1), \quad (3)$$

$$o_1 = g(Vs_1). \quad (4)$$

$f(\cdot)$ and $g(\cdot)$ are both activation functions. $f(\cdot)$ can be an activation function such as tanh, ReLU, and sigmoid, while $g(\cdot)$ is typically a softmax function. The state s_1 at this time is used as the memory state of the current moment, according to the sequence. It will take part in the next moment's activities.

$$h_2 = Ux_2 + Ws_1, \quad (5)$$

$$s_2 = f(h_2), \quad (6)$$

$$o_2 = g(Vs_2). \quad (7)$$

By analogy, the final output is as follows:

$$h_t = Ux_t + Ws_{t-1}, \quad (8)$$

$$s_t = f(h_t), \quad (9)$$

$$o_t = g(Vs_t). \quad (10)$$

RNN has a good effect on time-series problems. However, when the parameters are unchanged during the training process, the gradient will be continuously multiplied during the backpropagation process, and the value will

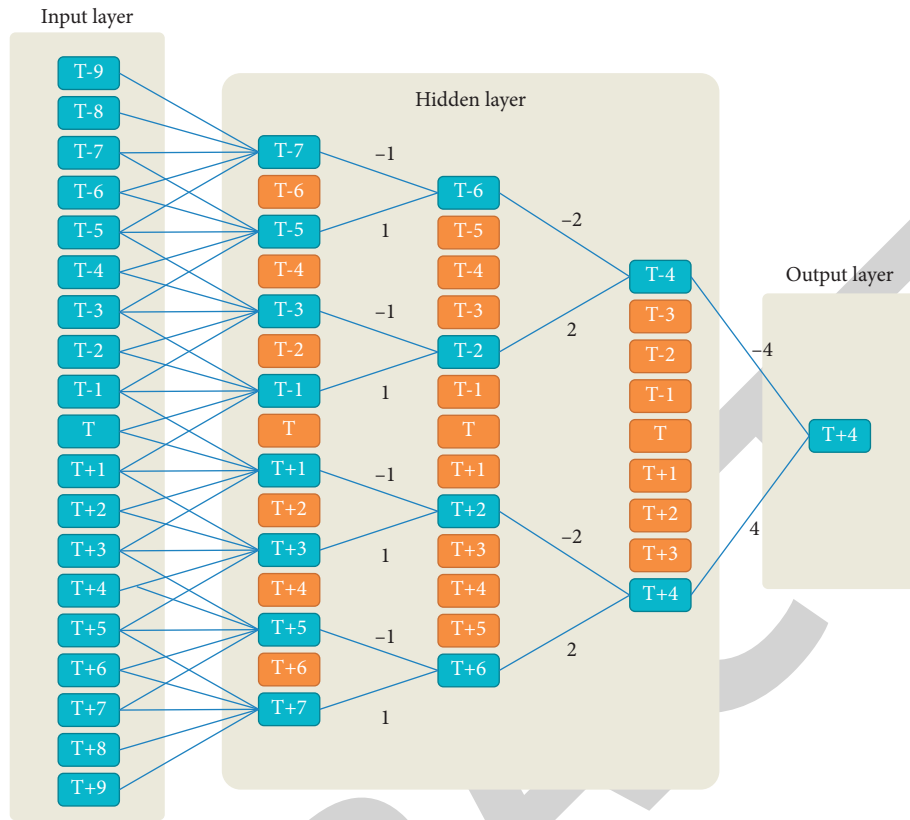


FIGURE 4: TDNN structure.

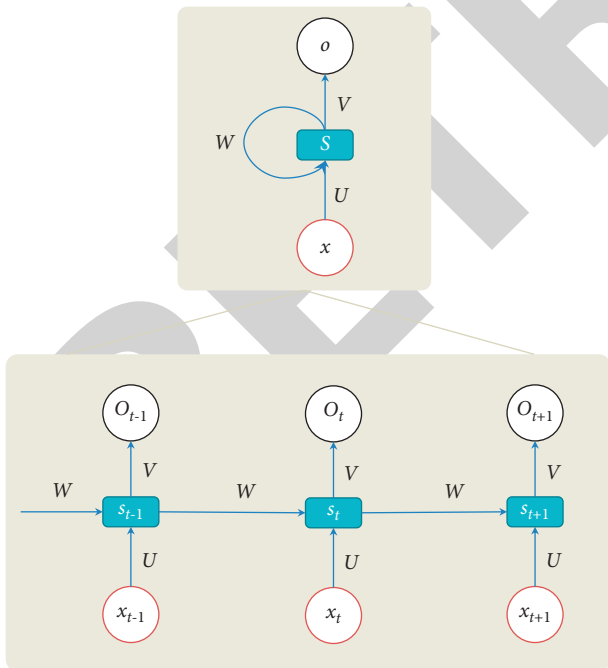


FIGURE 5: RNN structure.

become larger or smaller. This can lead to problems such as exploding gradients or vanishing gradients. LSTM is a special kind of RNN that can solve the time dependence problem very well. Therefore, LSTM is introduced to solve

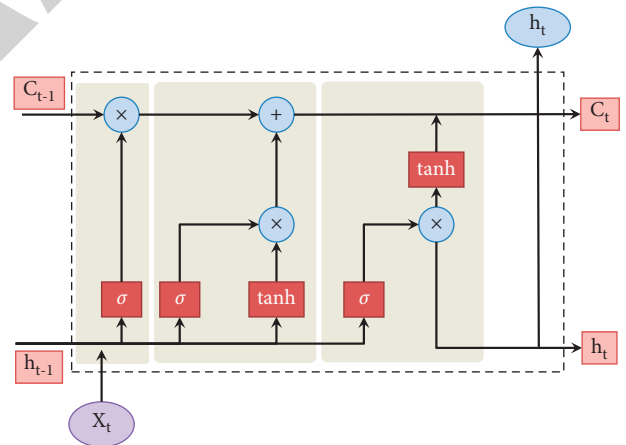


FIGURE 6: LSTM structure.

the above problems. Compared with RNN, LSTM is calculated based on the input and the output of the hidden layer at the previous moment, but it changes the internal structure of the RNN hidden layer. The neurons of LSTM include input gate i , forget gate f , output gate o , and internal memory unit C . Figure 6 shows the LSTM structure.

The forget gate is controlled by sigmoid. A f_t value from 0 to 1 is generated based on the output h_{t-1} at the previous moment and the current input x_t . This value is used to decide whether to forget or forget part of the information C_{t-1} learned at the last moment., where w represents the weight matrix, b represents the bias vector, and σ represents the

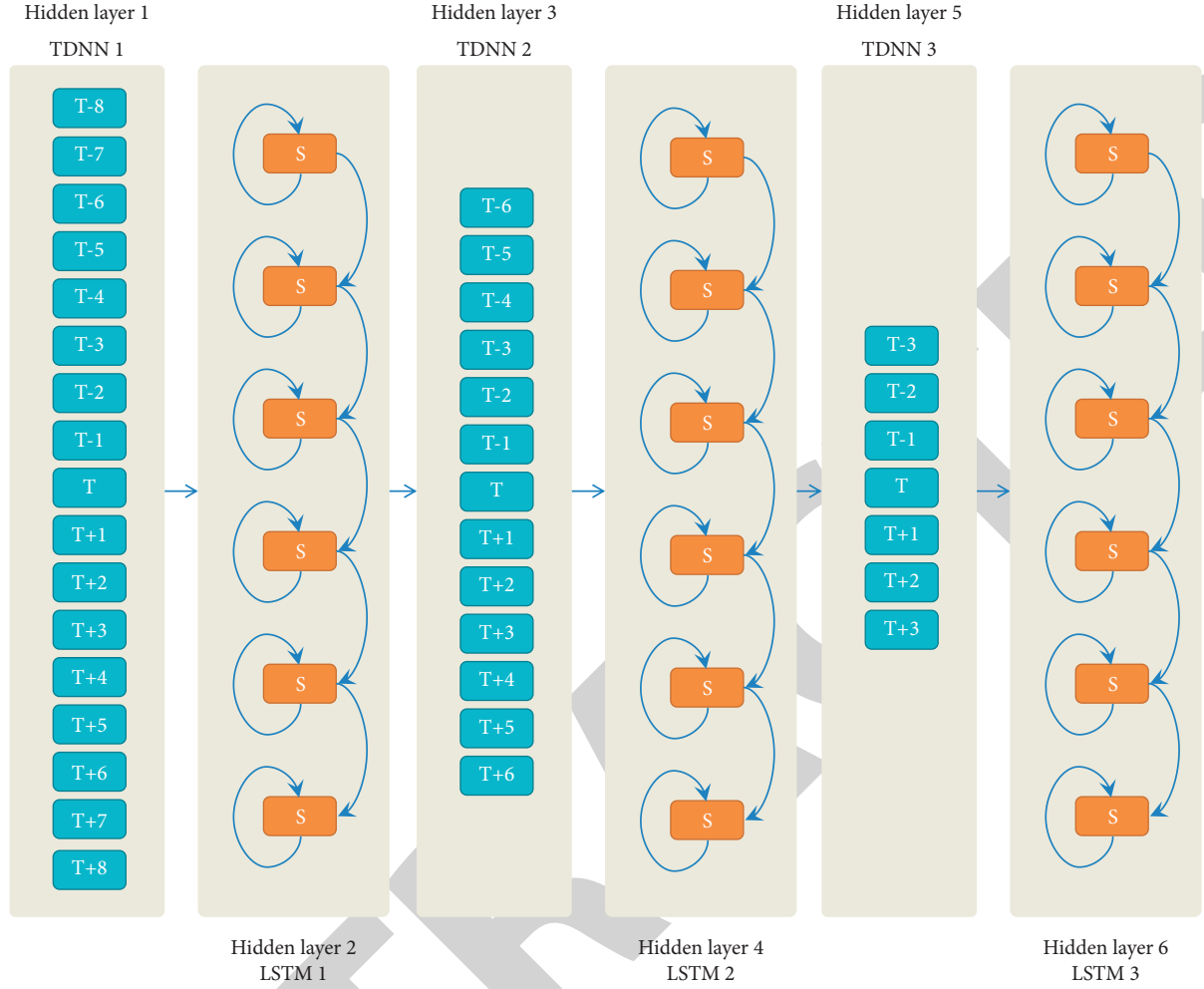


FIGURE 7: TDNN-LSTM structure.

nonlinear activation function. The formula for calculating the f_t value is shown as follows:

$$f_t = \sigma(w_f \cdot [h_{t-1}, x_t] + b_f). \quad (11)$$

The input gate uses sigmoid to decide which information needs to be updated. The tanh layer is to generate a new candidate value C_t , which may be added to the internal memory unit as a candidate value generated by the current layer. Combining the values generated by the above two parts, the model is updated as follows. First, the product information of the internal memory unit of the previous layer and f_t is used to forget the unnecessary information and then added with $i_t \times \tilde{C}_t$ to obtain the candidate value C_t . The calculation formula is as follows:

$$i_t = \sigma(W_i \cdot [h_{t-1}, x_t] + b_i), \quad (12)$$

$$\tilde{C}_t = \tanh(W_C \cdot [\mu_{t-1}, x_t] + b_C), \quad (13)$$

$$C_t = f_t \times C_{t-1} + i_t \times \tilde{C}_t. \quad (14)$$

The model's output is obtained by multiplying an initial output through the sigmoid layer and scaling the C_t value to a value between -1 and 1.

$$o_t = \sigma(W_o \cdot [h_{t-1}, x_t] + b_o), \quad (15)$$

$$h_t = o_t \times \tanh(C_t). \quad (16)$$

3.3. TDNN-LSTM Model. For tasks with strong timing information correlation, both TDNN and LSTM have superior modeling capabilities. LSTM training is more difficult than TDNN training. As a result, the TDNN-LSTM fusion model of TDNN and LSTM is used in oral English speech recognition. The model captures enough contextual information while reducing computational complexity. The TDNN-LSTM structure is depicted in Figure 7. As shown in the diagram, the network has six hidden layers. The single layer is known as TDNN, and the double layer is known as LSTM. The two models are arranged alternately. A unit module consists of a TDNN and an LSTM.

4. Experimental Analysis

4.1. Evaluation Indicators of Oral English Pronunciation. Many factors influence the quality of oral English output, including intonation, pitch, rhythm, and duration. In most

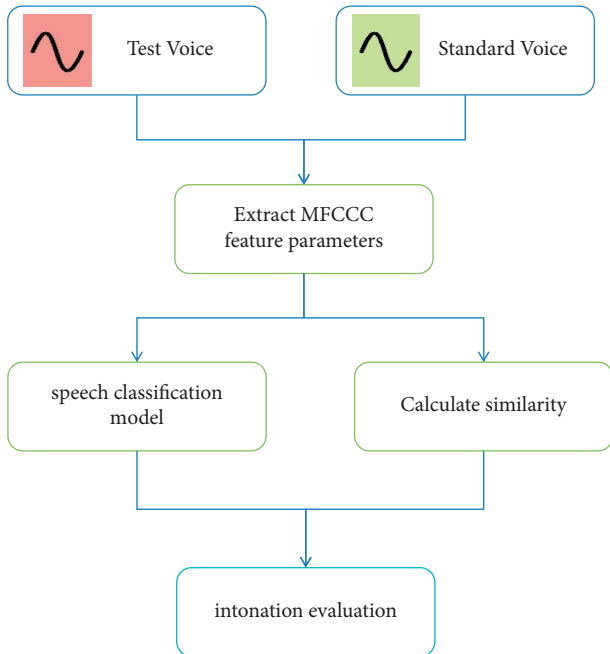


FIGURE 8: Principle of pitch evaluation.

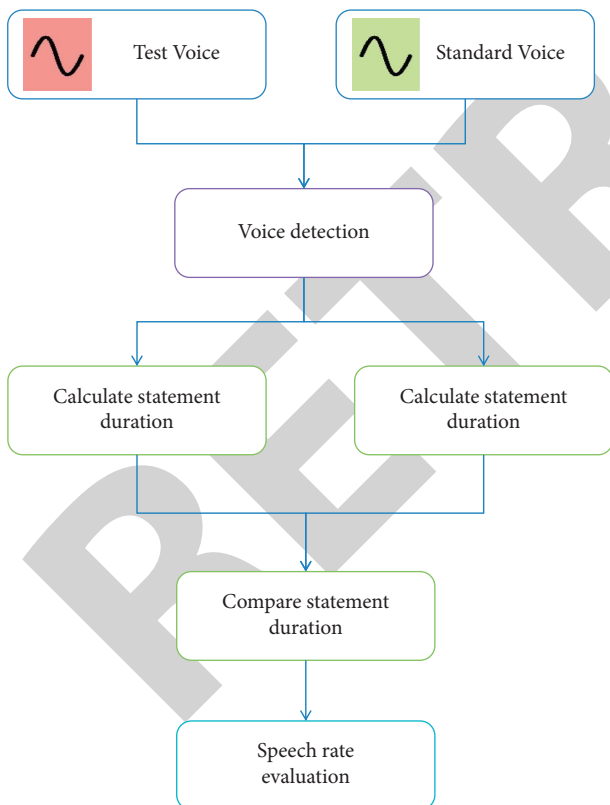


FIGURE 9: Principle of sound velocity evaluation.

cases, intonation is used as the primary indicator of the quality of oral English output, with other factors serving as auxiliary indicators. Pitch is primarily used to determine whether each word in the output sentence is correct and understandable. Figure 8 depicts the pitch evaluation principle.

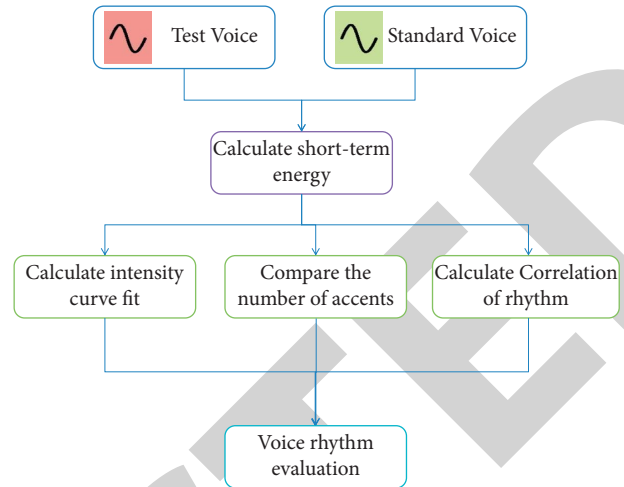


FIGURE 10: Principle of rhythm evaluation.

Speaking rate is also a key indicator of oral evaluation. The number of words produced by the speaker per unit time is referred to as the speech rate. If a student speaks 120 words in one minute, his speech rate is 2 words per second. Regardless of whether such a speech rate is fast or slow, it must be compared to the standard speech rate. The standard speaking rate for the same 120 words is 80 seconds, but the student only took 60 seconds, indicating that the student's speaking rate is too fast. Figure 9 depicts the sound speed evaluation principle.

Speaking rhythm is also very important. The difference between heavy, light, long, and short sounds when speaking a sentence is referred to as rhythm. The content of spoken language output differs, as does its rhythm. Many stressed syllables characterize the rhythm of oral English. Unstressed syllables between stressed syllables sound a little hazy. Figure 10 depicts the oral rhythm evaluation principle.

Many of the above aspects should be able to be evaluated by a good speaking assistance system. Furthermore, the weight of each factor is not the same. This study first validates the method's performance using the most fundamental and critical pitch indicator. The main purpose of pitch is to calculate the number of words recognized by the speech recognition module. The more correctly recognized words there are, the better the intonation.

4.2. Experimental Data. Thirty college students, 18 boys and 12 girls, were chosen for this study. In a quiet and comfortable classroom, students read prepared English sentences. Some examples of English sentences are shown in Table 1, with a total of 50 English sentences. At the same time, Sonar recording software is used. The sampling frequency is set to 16 KHz, and the encoding is 16 bit encoding. 30 students read out 50 sentences and recorded 1500 pieces of audio data. 1050 sentences of 1500 sentences are selected as training data and 450 sentences as test data.

4.3. Accuracy Recognition of Oral English. The speech signal must be preprocessed before it can be recognized as oral English. This preprocessing includes frame division

TABLE 1: Examples of English sentences.

-
- (1) What's happening?
 - (2) Nice to see you again
 - (3) I would like to talk to you for a minute
 - (4) The meeting was scheduled for two hours, but it is now over yet
 - (5) It took years of hard work to speak good English
 - (6) Mama used to say that life was like a box of chocolates. You never know what you'll get
 - (7) Do you think you'd be surprised if I changed into something more comfortable?
 - (8) Everything you see exists together in a delicate balance
 - (9) You know some birds are not meant to be caged; their feathers are just too bright
 - (10) Hope is a good thing, perhaps the best thing. And nothing good ever dies
-

TABLE 2: Recognition results of oral English by each model.

Index	Reference [26]	Reference [27]	Reference [28]	Reference [29]	Proposed
Accuracy	90.84	93.35	92.18	94.24	95.87
Precision	89.17	92.81	90.23	93.92	94.75
Recall	87.35	91.92	90.86	93.26	94.92

windowing, fast Fourier transform (FFT), Mel cepstral coefficient feature extraction, and other processes. The frame-by-frame windowing technique is used to compress the speech signal. When the length of the speech is between 10 and 30 milliseconds, it is considered a quasi-stationary signal. To divide the speech length into short segments, a window function must be added to the speech signal. Table 2 displays the results of each model's oral English recognition.

The comparison algorithms used are all DLAs, and the recognition rates of oral English pronunciation are all above 90%. This fully demonstrates the superior performance of DLAs. Compared with references [26–29], the proposed algorithm improves the accuracy by 5.5%, 2.7%, 4%, and 1.7%, respectively. The accuracy is improved by 6.3%, 2.1%, 5%, and 0.9%, respectively. The recall rates are improved by 8.7%, 3.3%, 4.5%, and 1.8%, respectively. The core model used in [26] is DNN. The core model used in [27] is LSTM. The core model used in [28] is BiLSTM. The core model used in [29] is CNN-BiRNN. The experimental results obtained by CNN-BiRNN in several models are relatively good. This method has a certain improvement on the basis of reference [29], although the improvement is not very obvious. The method in this study is based on the fusion of TDNN and LSTM model. In the classification of speech sequence data, LSTM can play a very good role. For oral English, since only the hidden state of the last time step is used in the LSTM classification task, it is not enough to fully express the spoken information. The complete accent information not only needs to obtain the pronunciation information of the past time but also needs to obtain the pronunciation information of the future time. There is a lot of prosody-related information in the accent. The prosody information is mostly information that echoes before and after; that is to say, it is necessary to determine the rhythm of the past moment. The rhythm of the future moment is also particularly important. TDNN-LSTM can simultaneously extract the prosody information of the past moment and the prosody information of the future moment to jointly determine the prosody information of the current moment.

5. Conclusion

The improvement of oral English learning demand has promoted the birth of various English-assisted teaching systems. The more classic software packages mainly include “talk to me” and “PhonePass Set”. These auxiliary software packages for improving oral English are not completely suitable for Chinese students to learn oral English. To study an oral English-assisted teaching system suitable for Chinese students, this study introduces a DLA and applies it to the quality assessment and error correction of oral English. The improvement of oral English is mainly carried out from two levels. One is to identify the overall quality of the learner's pronunciation and give a certain score. If the full score is 100, 90 to 100 is excellent, 80 to 90 is good, 70 to 80 is fair, 60 to 70 is pass, and below 60 is failed. In this way, learners have an overall understanding of their oral English. Only when learners clearly recognize their current level they can formulate goals that can be achieved. The second is to find out which words have problems with pronunciation and tell them the correct pronunciation. Words with completely wrong pronunciation are marked in red, inaccurate words are marked in yellow, and completely correct words are marked in green. To achieve the above two points, it is necessary to correctly recognize the input speech. The speech recognition model used in this study is a fusion model of TDNN and LSTM. Firstly, a time-delay neural network and a long short-term memory network are introduced successively to calculate the posterior probability of the model state, so as to model the context-dependent features. Finally, according to the structural characteristics of the long short-term memory network, the TDNN-LSTM hybrid network structure is introduced, and it will be applied to the English spoken pronunciation recognition task. The simulation results show that the method in this study has advantages compared with other deep learning methods and has certain reference value. There are still some shortcomings in this study. For example, the evaluation indicators used only use the core pitch indicators, and the important indicators such

as sound speed and rhythm have not been experimentally studied. In addition, the training of the used models is relatively complex, and the process needs to be further simplified. This study is mainly devoted to optimizing the English speaking assistant system from the technical level. However, for teachers, it is also necessary to use these auxiliary tools reasonably in the teaching process. The auxiliary system should be able to be applied to each link before, during, and after class. Therefore, enriching the functions of the auxiliary system is also the follow-up research plan of this study.

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 they have no conflicts of interest.

Acknowledgments

This work was supported by the Chuxiong Medical College.

References

- [1] J. J. Martins and P. F. do Amaral, "English language teaching in BRAZILIAN public schools nowadays," *REVISTA INCLUSIONES*, vol. 6, pp. 127–142, 2019.
- [2] I. Dzulkifli, "Teaching and learning aids to support the Deaf students studying Islamic Education," *PERTANIKAJOURNAL OF SOCIAL SCIENCE AND HUMANITIES*, vol. 29, no. 4, pp. 2263–2279, 2021.
- [3] S. Sugiman, H. Suyitno, I. Junaedi, and D. Dwijanto, "The Creation of teaching aids for Disabled students as Mathematical-Thinking-Imaginative product," *International Journal of Instruction*, vol. 13, no. 3, pp. 777–788, 2020.
- [4] T. Iio, R. Maeda, K. Ogawa et al., "Improvement of Japanese adults' English speaking skills via experiences speaking to a robot," *Journal of Computer Assisted Learning*, vol. 35, no. 2, pp. 228–245, 2019.
- [5] M. Gasic, D. Hakkani-Tur, and A. Celikyilmaz, "Spoken language understanding and interaction: machine learning for human-like conversational systems," *Computer Speech & Language*, vol. 46, pp. 249–251, 2017.
- [6] F. M. Jiao, J. Song, X. Zhao, P. Zhao, and R. Wang, "A spoken English teaching system based on speech recognition and machine learning," *INTERNATIONAL JOURNAL OF EMERGING TECHNOLOGIES IN LEARNING*, vol. 16, no. 14, pp. 68–82, 2021.
- [7] P. M. I. Seraj, H. Habil, and M. K. Hasan, "Investigating the problems of teaching oral English communication skills in an EFL context at the Tertiary level," *International Journal of Instruction*, vol. 14, no. 2, pp. 501–516, 2021.
- [8] R. F. Brena, E. Zuvirie, A. Preciado, A. Valdiviezo, M. Gonzalez-Mendoza, and C. Zozaya-Gorostiza, "Automated evaluation of foreign language speaking performance with machine learning," *International Journal on Interactive Design and Manufacturing*, vol. 15, no. 2-3, pp. 317–331, 2021.
- [9] S. Weigelt, V. Steurer, T. Hey, and W. F. Tichy, "Towards Programming in Natural language: learning new functions from spoken Utterances," *International Journal of Semantic Computing*, vol. 14, no. 02, pp. 249–272, 2020.
- [10] O. Kang and D. Johnson, "The roles of suprasegmental features in predicting English oral proficiency with an automated system," *Language Assessment Quarterly*, vol. 15, no. 2, pp. 150–168, 2018.
- [11] T. I. Monastyrskaya, T. B. Ganicheva, G. V. Toropchin, and A. V. Katsura, "Need for a Differentiated approach to teaching English in higher school: a Sociological study," *Modern Journal of Language Teaching Methods*, vol. 8, no. 9, pp. 24–36, 2018.
- [12] T. Hagendorff, "Linking human and machine Behavior: a new approach to evaluate training data quality for Beneficial machine learning," *Minds and Machines*, vol. 31, no. 4, pp. 563–593, 2021.
- [13] J. M. Bone, C. M. Childs, A. Menon et al., "Hierarchical machine learning for high-Fidelity 3D Printed Biopolymers," *ACS Biomaterials Science & Engineering*, vol. 6, no. 12, pp. 7021–7031, 2020.
- [14] G. Giantamidis, S. Tripakis, and S. Basagiannis, "Learning Moore machines from input-output traces," *International Journal on Software Tools for Technology Transfer*, vol. 23, no. 1, pp. 1–29, 2019.
- [15] S. A. Seshia, S. Jha, and T. Dreossi, "Semantic Adversarial deep learning," *IEEE DESIGN & TEST*, vol. 37, no. 2, pp. 8–18, 2020.
- [16] J. S. Park and J. H. Park, "Enhanced machine learning algorithms: deep learning, reinforcement learning, and Q-learning," *JOURNAL OF INFORMATION PROCESSING SYSTEMS*, vol. 16, no. 5, pp. 1001–1007, 2020.
- [17] Y. Matsuo, Y. LeCun, M. Sahani et al., "Deep learning, reinforcement learning, and world models," *Neural Networks*, vol. 152, pp. 267–275, 2022.
- [18] L. A. Zavala-Mondragon, B. Lamichhane, L. Zhang, and G. d. Haan, "CNN-SkelPose: a CNN-based skeleton estimation algorithm for clinical applications," *Journal of Ambient Intelligence and Humanized Computing*, vol. 11, no. 6, pp. 2369–2380, 2020.
- [19] H. Kwon, M. Pellauer, A. Parashar, and T. Krishna, "Flexion: a quantitative Metric for Flexibility in DNN Accelerators," *IEEE Computer Architecture Letters*, vol. 20, no. 1, pp. 1–4, 2021.
- [20] S. Dutta, J. K. Mandal, T. H. Kim, and S. K. Bandyopadhyay, "Breast Cancer prediction using Stacked GRU-LSTM-BRNN," *Applied Computer Systems*, vol. 25, no. 2, pp. 163–171, 2020.
- [21] O. Z. Mamyrbayev, K. Alimhan, B. Amirgaliyev, B. Zhumazhanov, D. Mussayeva, and F. Gusmanova, "Multimodal systems for speech recognition," *International Journal of Mobile Communications*, vol. 18, no. 3, pp. 314–326, 2020.
- [22] K. Rangra and M. Kapoor, "Exploring the mel scale features using supervised learning classifiers for emotion classification," *INTERNATIONAL JOURNAL OF APPLIED PATTERN RECOGNITION*, vol. 6, no. 3, pp. 232–253, 2021.
- [23] V. V. Yerigeri and L. K. Ragha, "Speech stress recognition using semi-eager learning," *Cognitive Systems Research*, vol. 65, pp. 79–97, 2021.
- [24] J. Monteiro, J. Alam, and T. H. Falk, "Multi-level self-attentive TDNN: a general and efficient approach to summarize speech into discriminative utterance-level representations," *Speech Communication*, vol. 140, pp. 42–49, 2022.
- [25] J. Kim, Y. Lee, and E. Kim, "Accelerating RNN Transducer Inference via Adaptive expansion Search," *IEEE Signal Processing Letters*, vol. 27, pp. 2019–2023, 2020.

Retraction

Retracted: Research on the Application of Improved K-Means Spatial Clustering Algorithm in Landscape Conservation of Gardens

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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] H. Sun and Y. Yang, "Research on the Application of Improved K-Means Spatial Clustering Algorithm in Landscape Conservation of Gardens," *Security and Communication Networks*, vol. 2022, Article ID 3148223, 11 pages, 2022.

Research Article

Research on the Application of Improved K-Means Spatial Clustering Algorithm in Landscape Conservation of Gardens

Hao Sun¹ and Yuanyuan Yang²

¹Department of Architectural Environment Art, Xi'an Academy of Fine Arts, Xi'an 710065, Shaanxi, China

²Jiaodai Senior High School, Lantian, Xi'an 710515, Shaanxi, China

Correspondence should be addressed to Hao Sun; rock782021@163.com

Received 7 June 2022; Revised 6 July 2022; Accepted 18 July 2022; Published 6 September 2022

Academic Editor: Tao Cui

Copyright © 2022 Hao Sun and Yuanyuan Yang. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Garden art is the culture of generations since ancient times and is another spiritual carrier of people's internal admiration for natural landscape, culture, and art as well as their love for living in nature and landscape. This article mainly studies the data clustering algorithm and adopts a research methodology that progresses from simple to complex. It starts by establishing a spatial data clustering model and then clustering the low-dimensional data, and then processing the high-dimensional spatial data in the low-dimensional data set. The original K-means clustering algorithm is then improved, and the new algorithm is created by combining PSO with the K-means algorithm in the high-dimensional spatial data set. And the improved two algorithms are applied to the study of data related to landscape conservation sites, and the powerful superiority of the improved K-means spatial clustering algorithm in this article is verified through the comparison of the algorithms.

1. Introduction

Garden art is the culture of generations since ancient times. It is another spiritual carrier of people's internal reverence for natural landscape and cultural art; sentiment in nature and landscape life, culture, and art; and historical inheritance in the traditional culture of our Chinese nation for five thousand years. Oriental architecture culture has gradually penetrated not only the entire human landscape industry civilization development but also the most original historical lineage. It renders the unique regional characteristics, distinctive style of garden art architecture, beautiful sculpture production process, full of ancient oriental humanistic wisdom charm of mysterious ancient folk religion philosophy, complete and rich connotation of traditional folk morality and ethics. The world's historical and cultural landscape heritage of the garden art category is composed of the sculptural craftsmanship, the mysterious ancient folk religion and philosophy full of the charm of the ancient Eastern human wisdom, the complete and rich traditional folk morality and ethics, the excellent oriental poetry and

songs like the universe, and the profound and colorful ancient folk language and script.

As one of the first countries in Asia to start building large-scale modern urban garden projects, recognized in the history of modern world architecture, Chinese garden projects have long been known as the "mother of gardens" in the world (Figure 1).

The two core objectives of the work on the conservation of the ecological diversity of the cultural landscape of gardens are as follows: the sustainable conservation of landscape resources and their restoration methods; and the sustainable development of landscape resources. Chinese scholars are still in the stage of theoretical exploration of the scientific conservation theory of natural resources in Chinese gardens and cultural landscapes, and no relatively systematic and mature research has been established at home and abroad. The scientific conservation of China's key cultural landscape environment still needs relevant academic methods and theories. This article focuses on the use of an improved and optimized K-means spatial clustering algorithm model to explore the contemporary Chinese

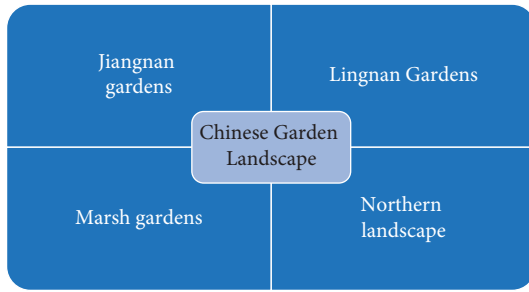


FIGURE 1: Four categories of Chinese gardens and landscapes.

landscape conservation methods and theoretical systems and then gradually realizes the effective and sustainable scientific protection and restoration development of China's cultural landscape and the reasonable continuation of the tourism industry development and operation mode. To achieve the integration of resources and the homeland landscape's natural scenery, one must fully exploit the traditional advantages of Chinese national culture.

1.1. Research Background. At present, various inappropriate measures of conservation management methods and excessive use of various unreasonable means have caused the conservation work to be stretched to the limit [1]. The current domestic professional laws and regulations on the protection and management of historical and cultural landscape resources are searched, and related technical research and thesis materials are few and far between. The general lag in the development of laws and regulations and the relative lack of technical means of protection and management have also led to different degrees of damage to the protection of each major cultural landscape in China [2].

The current domestic government is not very optimistic about the overall conservation status of traditional cultural landscape protection, and a thousand cities are one-sided and have lost their individuality. The huge cultural gap in the protection concept also makes the government of almost every provincial capital city in the overall protection of the cultural landscape share some similarities in thinking. Unscientific cultural planning and construction have also delayed the long-term natural evolution of urban cultural landscape laws and operating mechanisms [3]. At the same time, due to the basic judgment, concept overview, theoretical principles of protection and utilization, and the application of management practice methods of important cultural landscape resources in China, there are generally some serious cross confusion in the scope of understanding and lack of clear and complete systematic definition, and its resource protection application problem will increasingly evolve into an important realistic issue that restricts the research of ecological and cultural tourism protection and development [4].

Although there is a certain degree of commonality with the professional national laws and regulations on the protection of cultural monuments and sites in terms of focusing on the protection of cultural landscapes of the garden type, they are significantly different in several aspects such as

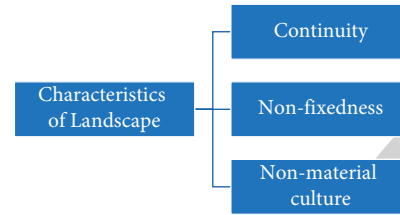


FIGURE 2: Main characteristics of landscape gardening.

assessment criteria, identification of heritage subjects, the scope of areas involved, management requirements, and socioeconomic roles. As a result, China's current regulations on the protection of ecological and cultural heritage are, to a certain extent, not entirely theoretically relevant and legally operable.

1.2. Concept Definition

1.2.1. Definition of Garden Landscape. Combined with the national garden culture defined in the natural heritage standard system of "nature and the joint action of mankind"-related definition, generally, believe that not all natural garden landscapes can be called national garden cultural landscape heritage, only for those who do establish in the natural mountains, rivers, lakes, and wetlands, such as the room, after a long period of human landscape environment maintenance management and appropriate decoration and beautification. The initial formation of some natural garden relics can only be officially called natural landscape garden architectural heritage (Section 1.1).

1.2.2. Characteristics of the Garden Landscape. The landscape has three main characteristics: continuity, nonfixedness, and nonmaterial culture [5] (Figure 2).

(1) *Continuity.* The formation and development of a cultural landscape, which is both a natural phenomenon and a type of common artwork created by human society, must undergo a lengthy, complex, and diverse integrated cultural process. As a result, garden class cultural landscapes, which have many parts and basic components, are more vivid and full and also exhibit more typical characteristics, allowing them to accurately reflect the cultural activities of a particular geographical era and long-term history [6]. It is based on this historical era of the garden cultural accumulation and landscape natural long-term interaction relationship, so that the garden class cultural landscape widely become a historical classic and the most easily appreciated by generations of future generation collection of the direct internal reasons.

(2) *Nonfixedness.* The natural landscape, cultural activity relics, and artificial garden landscape are the three main components of the garden-like cultural landscape. The natural landscape and the garden landscape serve as the two main material carriers for this composition. These natural landscapes have a more obvious relative nonfixed nature [7].

First, the natural landscape is also a living landscape, climate change, geological plate movement, plant growth and reproduction and evolutionary succession activities will change a natural landscape. A natural landscape will change due to a variety of factors, including climatic change, geological plate movement, plant growth and reproduction, and evolutionary succession. Second, all the green plant landscapes, garden constructions, paths, and other artificial natural landscape environments in the garden landscape environment will change or disappear accordingly with the passage of time. Finally, the material cultural landscape is always in some kind of dynamic change cycle, extinction, reconstruction, alteration, and local new construction activities are a major objective reason affecting the overall formation and development of the cultural landscape of the garden category [8]. Therefore, the content of the main material carrier in the cultural landscape of the garden is not completely fixed change. This nonfixed nature is also expressed in the dynamic change of the cultural landscape space, on the one hand, and, on the other hand, in the “historical landscape” and “existing landscape” of time dislocation and space overlap.

(3) *Nonmaterial Culture*. The nonmaterial cultural content in the cultural landscape of the garden refers to the cultural activities and historical events attached to the material cultural landscape. These nonmaterial cultural contents are the soul of the garden-like cultural landscape and are very important. Intangible cultural content means the important content that distinguishes the garden-type cultural landscape from other categories of cultural heritage [9].

2. Literature Review

Relevant journal articles on garden conservation include: “The Conservation and Repair of Ancient Chinese Gardens,” “The History and Review of the Conservation and Repair of Yu Garden in Shanghai,” “A Preliminary Study on the Conservation and Utilization of Ming and Qing Historical Gardens in Nanjing,” “The Characteristics of the Giant Stone Garden of Chongqing Jukui Academy and its Conservation and Utilization,” “Research on the Conservation and Development Measures of Classical Gardens in Suzhou,” “An Exploration of the Definition of the Scope of the Conservation and Control of the Historical and Cultural Reserve of Qing Dynasty Royal Gardens in the Western Suburbs of Beijing,” “Classical Gardens Protection and Restoration Should Be Based on the Theory of Garden Tradition,” “On the Authenticity of Protecting Historical Garden Heritage,” “Royal Garden Cultural Space and Cultural Heritage Protection,” etc [10]. In terms of regional cultural gardens, these articles have undertaken some research on their protection, usage, regeneration, and renewal; however, there are fewer studies on the theoretical principles and methods for protection and regeneration [11].

Relevant master’s theses on garden conservation are shown in the following.

In 2004, Zhang Yu’s article “A Preliminary Study on the Conservation of Dunheyuan” recognized and analyzed the history of the Summer Palace; the original purpose of gardening, historical value, artistic value, cultural accumulation, and technical connotation; and proposed conservation strategies and methods for the current state of conservation of the Summer Palace; The conservation methods were refined through two levels of internal conservation and external control [12].

In 2005, Jin Hainan’s article “A Trial on the Conservation and Renewal of Historic Gardens in the Shizhahai Area” analyzed the landscape characteristics of historic gardens in the Shizhahai area; made conservation suggestions for the existing problems in the conservation of historic gardens in the Shizhahai area; and made targeted conservation suggestions in terms of water quality, gardens, new buildings, environment, and night scenery. The recommendations were made for the preservation and utilization of the Wangfu Garden from the internal and external environment and the coordination area [13].

In 2006, Li Zaihui’s article “Tianjin Concession Gardens and Conservation” studied the formation, development, and style of Tianjin concession gardens and proposed three levels of the legal system, implementation, and archival records to protect concession gardens measures for the year [14].

In 2007, the thesis of Bian Ji’s “Research on the conservation planning of historical gardens” made a full explanation of the concept, characteristics, and value system of historical gardens and proposed methods to conserve historical gardens from maintenance and protection, restoration and reconstruction, prudent utilization, and public participation through the content of relevant domestic and foreign studies [15]. Cheng Li’s article “Conservation and Utilization of Beijing Altar Gardens: The Case of Zhongshan Park” introduces the history and current situation of Beijing Tiantan gardens and identifies the main problems and contradictions of Zhongshan Park based on its history and field survey and proposes conservation measures to improve laws and regulations, foreign registration system, fund management, camp management, and public participation for Zhongshan Park. Team, experts and scholars, public participation, cultural resources and other aspects of conservation [16].

In 2012, Wu Tao’s thesis on “Preservation and Heritage of Yangzhou Historical Gardens Based on Regional Culture” mainly analyzed the problems of conservation and restoration of Yangzhou historical gardens by addressing the current situation of their conservation and proposed an overall strategy and framework for the conservation and restoration of Yangzhou gardens in a targeted manner in terms of specific means and methods of conservation and restoration to establish the operational process of conservation and restoration. It also proposes four aspects of the conservation system in terms of establishing the operational process of conservation and restoration, conservation and restoration of space, developing evaluation standards and technical specifications for conservation and restoration, and determining the basic means and ways of conservation and restoration [17].

3. Brief Description of the Method

3.1. The Basic Idea of Clustering Algorithm. Among the classification studies in the past, people mainly rely on the experience generated by accumulation and learning to master the expertise to solve some problems related to clustering; the frequency of using mathematical methods is very low. However, as the complexity of the actual problem increases, it becomes more difficult to solve realistic and complex problems by relying only on past experience and expertise, so cluster analysis emerges.

In general, there may be different degrees of similarity among the samples or indicator variables we study [18]. Then, according to the value of some observed indicators of the sample, we find some statistics that can measure the similarity between samples or indicators, and based on this, the samples or indicators with greater similarity are clustered into one category each. After the clustering is completed, the indicators that are closely related to each other will have a greater degree of similarity and will be clustered into one class; the indicators that are distant from each other will have a smaller degree of similarity and will be clustered into another class, so that after all the samples are measured, the indicators will be divided into different classes according to the degree of similarity.

In economic, social, and demographic development research activities, there are new problems in research and construction of new classifications involving a large number of disciplines [19]. For example, in the practice of urban and rural economic survey and research, in order to accurately study the average income growth and actual consumption level of urban and rural residents in the living standards of urban and rural residents in different economic regions, it is often necessary to scientifically divide them into several different social types to analyze and study; however, due to the oldest former traditional taxonomic research, one of the main theoretical bases for the basis of classification is mainly life. However, because one of the main theoretical bases of the oldest traditional taxonomic research is the accumulation of experience and some professional theoretical knowledge, and because this foundation is rarely used to treat the classification phenomenon inductively, this inevitably results in some subjective thinking and deliberateness when doing the classification problem, and it is unable to accurately and quantitatively fully reveal some essential differences between law and logical connection of the intrinsic law of each objective form of things, especially in a complex classification problem that involves more complex factors [20]. The problem of qualitative classification often leads to a decrease in the overall accuracy of its classification study.

It is possible to cluster both by clustering the sample variables and also by clustering each of the other sample variables that directly affect the sample results at the same time. The clustering of variables affecting the sample function is generally referred to as variable Q-type cluster analysis, while the clustering of variables affecting the sample variables is referred to as function variable R-type cluster analysis [21].

3.2. K-Means Clustering Algorithm. Traditional clustering methods have various forms and different algorithms, and their main classifications are shown in Figure 3.

K-means algorithm belongs to one of the common algorithms in the division method, and its theory also belongs to a basic category of iterative optimization algorithm (optimization clustering), which generally requires the algorithm to satisfy a certain equalization function, as a basic criterion of the basic iterative optimization process, and iterate continuously to get each optimal cluster clusters [22]. Although it is said that the K-means algorithm is relatively easy and fast to implement, in fact, there are some limitations in the process of cluster calculation, iteration, and optimization: (1) the algorithm is sensitive to the initial cluster centroid; (2) it is easy to fall into the local optimal solution [23].

In order to solve the problems of K-means algorithm clustering, scholars have proposed different improvement methods, with the common purpose of avoiding clustering sensitive to the initial centroid; the most traditional method is to arbitrarily choose the initial point value, then calculate it several times, and finally select the best result inside the calculated result. Other algorithms use multiple sampling methods to generate different clustering centers, and then cluster the newly generated clustering centers to select the better clustering result, with the initial center selected by that clustering result as the optimal initial center. The literature uses the density method to calculate the density between data objects among sample data points to generate the sample initial points meritively. The literature calculates the density of the local area where each data sample point is located, and then selects the points in the k high-density areas that are farthest from each other as the initial center points [24]. The literature uses the method of estimating class feature centers to improve the algorithm, and the estimated class feature centers are used to initialize the K-means algorithm [25]. The literature proposes a method to select the initial cluster centers based on the data sample distribution, constructs k compact data sets using the greedy idea, and selects the mean value of the sample data in each set as the initial cluster centroid.

Traditional K-Means algorithm is used to further solve the current problem of selecting initial centroids when constructing clustered data; so this article tries to start from two aspects of how to solve the following problems, respectively: (1) In the problem of selecting the initial centroids, the main approach is to use greedy thinking to construct the number of clusters according to the distribution of samples. (2) Customizing a class function with interclass and intraclass correlation for equalization. An organic combination of these two is used for algorithm improvement [26].

3.3. K-Means Algorithm Modeling. Let the sample $X = \{x_i | i = 1, 2, \dots, n\}$ data $C_j (j = 1, 2, \dots, k)$ set, for the k classes that denote $C_j (j = 1, 2, \dots, k)$ clustering, denote the clustering centers of each $c_j = (1/n_j) \sum_{x \in C_j} x$ class, where n_j denotes the number of samples of each data set, and

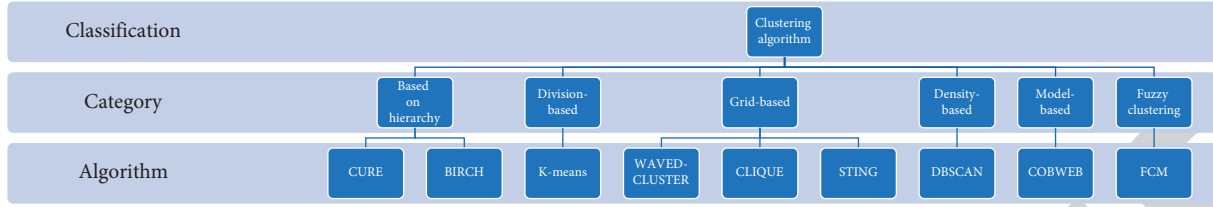


FIGURE 3: Classification of clustering methods.

the distance between two data objects uses Euclidean distance.

The K-means algorithm is mainly to find the objective function after several calculations to classify the given different data into different categories of the minimum value, which in turn maximizes the compactness and independence of the generated clusters.

$$J(c, k) = \sqrt{W(c) \times W(c) + b(c) \times b(c)}. \quad (1)$$

where

$$W(c) = \sum_{i=1}^k W(C_i) = \sum_{i=1}^k \sum_{x_i \in C_i} d(x, C_i)^2. \quad (2)$$

$$b(c) = \sum_{1 \leq j \leq i \leq k} d(c_j, c_i)^2.$$

Here, $W(c)$ denotes the difference of data points within a class, which can be defined by a variety of distance functions, the simplest being the calculation of the sum of squares of the distances from each point within a class to the center of the class to which it belongs; $b(c)$ denotes the difference of data sets between the classes, which is defined as the distance between the centers of different clusters.

Algorithm 1 is described as follows (Figure 4).

3.4. Initial Centroid Selection Algorithm for Data Samples.

The K-means algorithm is characterized by its sensitivity to initial values. Therefore, the selection of different initial points may lead to different clustering results. Since the clustering results depend on the initial centroids to a certain extent, different choices of initial centroids can make the clustering results very unstable. If the initial clustering center starts with a bad choice, it may lead to the final result being difficult to meet the expectation. To address the possible defects of the K-means algorithm that is too sensitive to the initial points, this article uses a data sample distribution algorithm, which can make improvements by selecting the initial clustering centers according to the data distribution dynamics [29].

Suppose the full set of samples for clustering is S , the full set S contains n sample data, the total number of clusters is k , and there are m factors affecting each sample data, then each data x can be expressed as $x = (x_1, x_2, x_3, x_4, \dots, x_m)$. The distance between data x and data y uses the Euclidean distance.

$$\text{dist}[x, y] = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2 + \dots + (x_m - y_m)^2}. \quad (3)$$

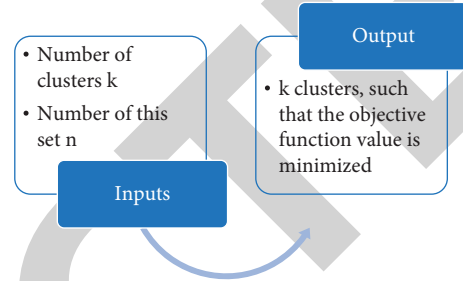


FIGURE 4: K-means algorithm modeling.

limit is defined as the threshold value, which is the maximum spatial distance allowed to join a certain set. It is expressed as

$$\text{limit} = \frac{((\max(\text{dist}[I, J]) - \min(\text{dist}[I, J]))}{k}. \quad (4)$$

The distance between data x and data set V is

$$\text{dist}[x, V] = \min(\text{dist}[x, v], v \in V). \quad (5)$$

The farthest distance between data x and data set V is

$$\text{Dist}[x, V] = \max(\text{dist}[x, v], v \in V). \quad (6)$$

In the K-means algorithm, data samples that are distributed in dense local areas are considered to have clusters at this point, so the average of these dense area data sets is often chosen as the initial clustering center [30]. To find the data set that is consistent with the data in terms of spatial distribution and can represent k clusters, Figure 5 is given (Algorithm 2).

3.5. Improved K-Means Algorithm for Initial Centroids and Evaluation Functions.

On the same data set, based on different input parameters, using the same clustering algorithm may end up with different clustering results, and for these different results generated, applying the already defined validity function to make a judgment, the optimal division can be finally obtained. According to such steps, this article first uses the initial centroid selection algorithm of data samples to precisely find out the initial clustering centroids and then applies a new evaluation function—equalization evaluation function—which can effectively find out the optimal clustering.

3.5.1. Equalization Evaluation Function. When clustering, the design of the evaluation function includes two main

Input: The number of clusters k and the number of sample sets n

Output: k clusters, so that the objective function value is minimized

- (1) Choose any k clusters from the n sample sets as the initial cluster centers, i.e., the mean value of this class [27].
- (2) Calculate the distance between the cluster center and each data in the sample set, and put the one with the smallest distance into the class where the cluster center point is located.
- (3) After new data points are added to each class, the mean value of the class is recalculated.
- (4) Loop step (2) and step (3) until the objective function J does not change, then the algorithm ends [28].

ALGORITHM 1: K-clustering algorithm.

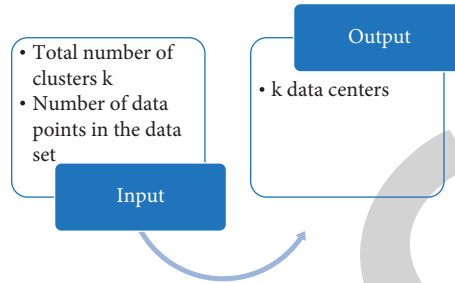


FIGURE 5: Initial centroid selection algorithm for data samples.

Input: Total number of clusters k and number of data points in the data set

Output: k data centers

- (1) Calculate the distance matrix according to $D = (d_{ij})$ the formula, where $d_{ij} = \text{dist}[i, j] (1 \leq i \leq n, 1 \leq j \leq n)$
- (2) Find the maximum and minimum values of the distance from the distance matrix D , and calculate the limit threshold value.
- (3) In the distance matrix D , find the two data a, b with the smallest distance, add the data a, b to the set, and $C_i (i = 1, 2, 3, \dots, k), C_i = \{a, b\}$ at the same time remove the data a, b from the set S , and update the matrix D .
- (4) Find the closest sample C_i, t in S . If $\text{Dist}[t, C_i]$ is less than the threshold, add tC_i to the set, while removing t from the set S , update the matrix D , and repeat step (4) using Eq. Otherwise, stop.
- (5) If $i < k, i = i + 1$, repeat steps (3) and (4) until the k sets are completed.
- (6) Take the $C_i (1 \leq i \leq k)$ average value of the data in the set noted as data center j , so that k data center points are selected.

ALGORITHM 2: K-mean space clustering algorithm.

factors: the similarity between data in each class is large, and the similarity between classes should be as small as possible. To achieve these two points, it is necessary to know the intraclass distance $W(c)$ and the interclass distance $b(c)$ of the clustering class C . The intraclass distance represents the distance between data points in the same class, and the interclass distance represents the distance between classes in different classes. The overall effect of clustering can be expressed and measured by the combination of intraclass and interclass distances. Based on this idea, the equalization evaluation function is obtained.

The equalization evaluation function is defined here as the quadratic root of the sum of the squares of the intraclass and interclass distances. The criterion function for clustering is the equalization evaluation function, and the equalization evaluation function is composed of overall intraclass distance and interclass distance functions, specifying that the algorithmic clustering effect is optimal when the value of the equalization function is the smallest.

$$\text{Min}\{J(c, k)\}. \quad (7)$$

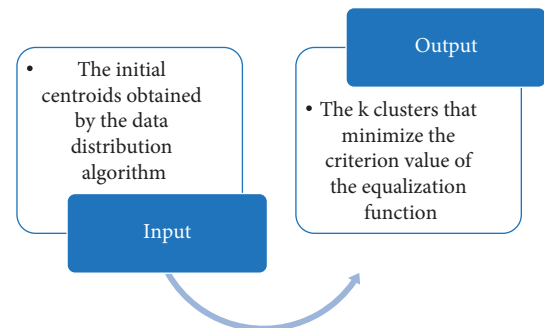


FIGURE 6: Improved K-means algorithm.

3.5.2. Improved K-Means Algorithm. According to the related literature, it is known that the result of k generally does not exceed \sqrt{n} . In this article, we improve the K-means algorithm, which does not need to give the value of k in advance, $k \sim \sqrt{n}$ can be taken from $(n$ is rounded), and the K-means algorithm is executed cyclically, and the smallest one is selected among the equalization function values, and

Input: Initial centroids obtained by the data distribution algorithm

Output: k clusters that minimize the criterion value of the equalization function

- (1) Set the value of k so that it is 1, 2, ..., \sqrt{n} equal to.
- (2) Call the k objects determined by the initial centroid obtained by the data sample algorithm as the initial clustering centers.
- (3) Calculate the mean value in the obtained classes and place each sample object in the nearest class.
- (4) Update the mean value of each class.
- (5) Calculate the evaluation function according $J(c, k)$ to the formula, until it converges; otherwise, repeat step (3) and step (4).
- (6) Select the minimum value of the equalization function according $J(c, k)$ to the formula, and write down the corresponding k value that is the optimal number of clusters, at which point the algorithm ends.

ALGORITHM 3: Improved K-means space clustering algorithm.

the k value at this time is recorded, and this k value is the optimal number of clustering results. In this article, we start to select the initial centroid based on the data distribution method as shown in Figure 6 (Algorithm 3).

3.6. Spatial Data Clustering. Spatial data clustering (spatial clustering) is one of the important components of spatial data mining. As a research direction in cluster analysis, it refers to the grouping of each data object according to the similarity between items so that the data in each cluster reach a certain degree of similarity, while there are certain disparities between data in different classes, and further, the main distribution patterns of spatial data and related typical patterns can be found. Spatial data clustering has been widely used in urban planning, environmental monitoring, earthquake forecasting, military, market analysis, and many other fields, penetrating into many aspects of social life.

The PSO-based K-means data clustering algorithm, as the name implies, combines this PSO algorithm with the K-means algorithm, so that it can well achieve the result of correct classification of data by avoiding the defect that k needs to be specified in the K-means algorithm. However, in high-dimensional spatial data, the evaluation criterion function of the K-means clustering algorithm is limited, and if no improvement is made, then the results obtained are bound to be unsatisfactory.

In this article, the evaluation criterion function of K-means is improved so that it is related to both intraclass and interclass distances, thus adding weights to the intraclass and interclass distances that affect the evaluation criterion function to make it more effective in clustering; the tests in this article show that the improved algorithm has relatively high convergence and a high correct rate, which strengthens the effectiveness of the clustering effect.

In this article, the improved K-mean space clustering algorithm is called the clustering algorithm $K_{m,n}$ PSO, and its main process is shown in Figure 7.

4. Empirical Analysis

When there are many factors affecting the sample data, that is, when the dimensionality of the data is high, a “dimensional disaster” occurs, which refers to a situation where the computational complexity of the clustering algorithm increases exponentially as the number of dimensions

increases. Moreover, the higher the dimensionality, the more difficult it is to define the distance function in the clustering algorithm.

As it is more difficult to handle when clustering high-dimensional data, in high-dimensional data space, dimensional groups can be grouped by different types of dimensions, and we call this method of handling data as dimensional grouping method. In the relational spatial database, attributes are divided into various types, for example, they can be divided into spatial attributes and nonspatial attributes, and among spatial attributes, they can also be divided into geometric and nongeometric attributes and many other cases. According to this method, the number of dimensions is greatly reduced, and the original high-dimensional spatial data set is split into multiple groups of low-dimensional data sets, and improved algorithms can be applied to the low-dimensional data sets, and the clustering results obtained at this time are more accurate. The basis of dimensional grouping can be set according to the characteristics of the actual database.

In this article, we selected the indicators and data related to landscape conservation from 2000 to 2021 and obtained the initial data set with 21 dimensions, which we divided into three clustering influence factor groups, A1, A2, and A3, according to the dimensional grouping method, and the number of clustering influence factors in each group is 7 dimensions, and each clustering influence factor group is divided into three classes of $K_{m,n}$ PSO each using the algorithm in the previous chapter of this article, and then using the index conversion method. The conversion is then performed.

First, for a high-dimensional data set, all samples are clustered on the first spatial influence factor group obtained by the clustering method, and some clusters are obtained; then the results obtained by clustering on the first spatial influence factor group are clustered on the second clustering influence factor group by clustering $K_{m,n}$ PSO method, and some other clusters are obtained, and this time the results obtained in the second clustering influence factor group are clustered on the third clustering. The final clustering results are obtained by applying the same method to the third cluster of influencing factors until all clusters of influencing factors have been processed.

For example, there are three clustering influence factor groups, also called dimension groups, A1, A2, and A3, respectively. First, two classes (1, 3, 5, 6, 10) and (0, 2, 4, 8, 9)

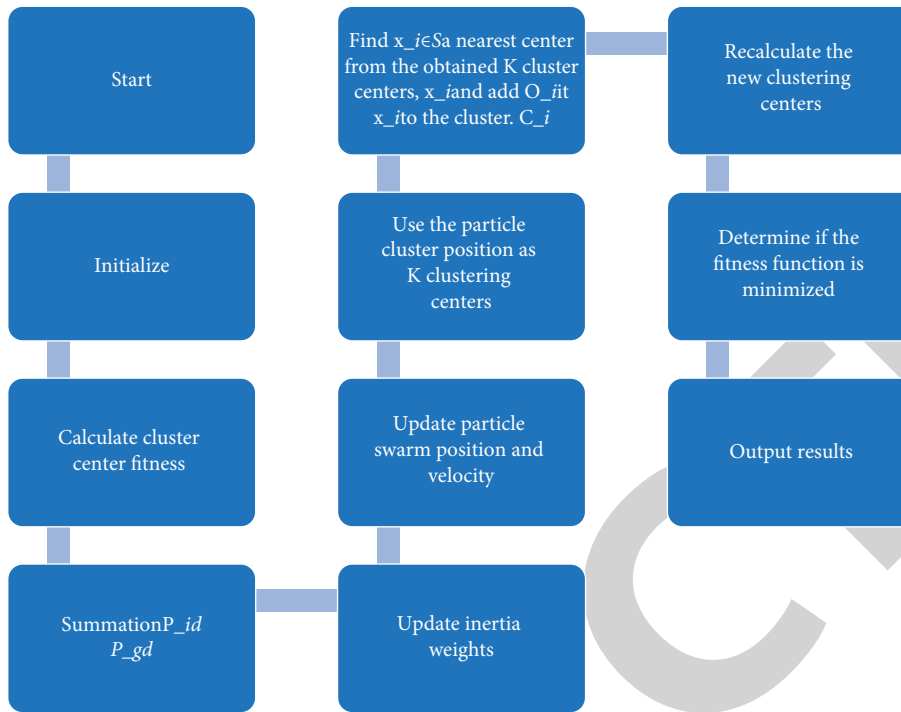


FIGURE 7: $K_{m,n}$ PSO flow of clustering algorithm.



FIGURE 8: Clustering results.

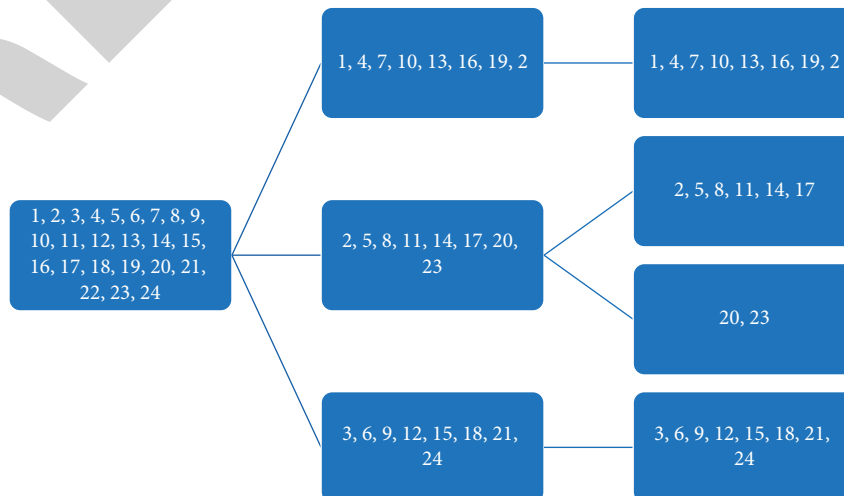


FIGURE 9: Clustering results.

are $K_{m,n}$ PSO obtained by clustering on the whole sample data set using the clustering method on the A1 dimension group, and then the same method is applied on the A2 dimension to first cluster (1, 3, 5, 6, 10) clustering to get two classes (3, 5) and (1, 10), and similarly clustering (0, 2, 4, 8, 9) in A2 dimension to get two more classes (0, 2, 8) and (4, 9), followed by clustering (3, 5), (1, 10), (0, 2, 8), and (4, 9) in A3 dimension again to get the final clustering results (3, 5), (1, 10), and (2, 8). The clustering process is shown in Figure 8.

The given landscape conservation data are then divided into two dimensional groups, namely A1 and A2. There are 24 groups of data to be grouped, and the 24 groups are numbered as 1, 2, . . . , 24; first, the whole sample data set is clustered on the A1 dimensional group using the clustering method to obtain three classes of $K_{m,n}$ PSO (1, 4, 7, 10, 13, 16, 19, 22), (2, 5, 8, 11, 14, 17, 20, 23), and (3, 6, 9, 12, 15, 18, 21, 24), and then apply the same method to cluster (1, 4, 7, 10, 13, 16, 19, 22) first in A2 dimension to obtain one class (1, 4, 7, 10, 13, 16, 19, 22) and cluster (2, 5, 8, 11, 14, 17, 20, 23) in A2 dimension to obtain two classes (2, 5, 8, 11, 14, 17) and (20, 23), and one class (3, 6, 9, 12, 15, 18, 21, 24) was obtained by clustering on (3, 6, 9, 12, 15, 18, 21, 24) in A2 dimension. The clustering process is shown in Figure 9.

According to the dimensional grouping and dimensionality reduction method, the national landscape conservation data are clustered with a total distance of four classes, but our correct clustering should be three classes, and the 20th and 23rd data should be clustered as the second class, so the correct rate of clustering by this method is 91.7%. The dimensional grouping and dimensionality reduction method does simplify the complexity of clustering and solve the problem of “dimensional distress,” but at the same time, it has a limited scope of use and can only be applied to relational databases; moreover, the accuracy of clustering obtained after dimensionality reduction by this method is not high, and we can also improve this method from these two aspects in the process of future research.

5. Conclusions and Recommendations

In this article, we mainly study the data clustering algorithm and adopt the research method from simple to complex; first, we establish the spatial data clustering model to cluster the low-dimensional data, then process the high-dimensional spatial data, improve the original K-means clustering algorithm in the low-dimensional data set, and combine the PSO with K-means algorithm in the high-dimensional spatial data set to get the new algorithm. And the improved two algorithms are applied to the corresponding data sets, and the powerful superiority of the improved K-means spatial clustering algorithm in this article is verified through the comparison of the algorithms.

For landscape conservation, the following proposed measures are put forward according to the research results.

5.1. Reconstructing the Protection System. It is necessary to develop a protection system for the protection of cultural landscape heritage of gardens according to the Convention

for the Protection of the World Cultural and Natural Heritage and other national regulations to protect its “authenticity” and “integrity.”

5.2. Extracting the Value Elements. Historical development of literature on the past and present life of the garden landscape for in-depth investigation and research, the site of its historical and humanistic summary, will provide richer historical resources for the cultural landscape. The collection of books related to humanities background can be a background understanding of how the landscape was formed and know what kind of humanities background has forged the landscape.

5.3. Protecting the Internal Environment. Garden landscape is largely derived from a good natural ecological environment, whether it is the internal natural vegetation or the surrounding peripheral environment, the Feng Shui grass movement will constitute a great impact on the environment. The same good natural ecological environment is the root of the landscape; mountains, water, flowers, and trees are the bones, blood, and hair of the landscape; one cannot be missing, and the natural ecological environment is constituted by the dynamic springs and pools and the flowers and trees in the four seasons. In addition, ancient trees and trees file are important elements of the landscape, are also a precious natural heritage of the landscape, and should be established for the protection of these ancient trees and trees file. Second, as a classical garden, the atmosphere of its viewing and the creation of mood is particularly important. The number of visitors per moment should be limited, should not accept a large number of tourists, should allow visitors to have a good viewing experience and spiritual perception, should be under the premise of controlling the number of tourists in the scenic area, and then should be limited through management measures to view the flow. In the premise of landscape protection while ensuring the visitor experience, can be controlled by receiving free tickets and advance reservation and can stay in the peak time limit and other ways to control the flow of people at all times to ensure the environmental experience. In addition to ensure the effect of water features, tap water can be introduced for concealed treatment. Finally, if the main garden building is relatively well protected, there is a risk of being damaged due to unreasonable use, and the impact of natural weathering requires good periodic inspection and maintenance. Compared to the main building, the garden structures and some of the miniatures are damaged by both natural and man-made influences and need to be updated and protected in a timely manner.

5.4. Controlling the External Environment. This includes the control of the external environment, the continuity of public opinion propaganda, and the control of external traffic. The control of external environment includes reasonable delineation of the external environment control area, adjustment of the nature of some surrounding sites, and reasonable organization of traffic environment. Public

opinion propaganda can be carried out through on-site display, thematic museum, network propaganda, publication propaganda, media propaganda, etc. External traffic control is carried out through external diversion, selective expansion, signal guidance, etc., to control and balance the flow of people in each attraction.

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 no conflicts of interest.

References

- [1] W. Liu, B. Zuo, and S. Qu, "A reasonable distribution of natural landscape: utilizing green space and water bodies to reduce residential building carbon emissions," *Energy and Buildings*, vol. 267, 2022.
- [2] S. Song, S. Wang, M. Shi, S. Hu, and D Xu, "Urban blue-green space landscape ecological health assessment based on the integration of pattern, process, function and sustainability," *Scientific Reports*, vol. 12, no. 1, p. 7707, 2022.
- [3] J. Lu, H. Cai, Y. Fu, X. Zhang, and W Zhang, "A study on the impacts of landscape structures on water quality under different spatial scales in the Xiangjiang River Basin," *Water, Air, & Soil Pollution*, vol. 233, no. 5, p. 164, 2022.
- [4] A. Moreno, A. J. Rescia, S. Pascual, and M Ortega, "Methodological approach to spatial analysis of agricultural pest dispersal in olive landscapes," *Environmental Monitoring and Assessment*, vol. 194, no. 6, p. 411, 2022.
- [5] S. K. Gupta and A. C. Pandey, "PROSAIL and empirical model to evaluate spatio-temporal heterogeneity of canopy chlorophyll content in subtropical forest," *Modeling Earth Systems and Environment*, vol. 8, no. 2, pp. 2151–2165, 2022.
- [6] A. van der Mescht, J. S. Pryke, R. Gaigher, and M. J. Samways, "Sympatric bush cricket species co-exist across a complex landscape by optimising both acoustic and ecological space," *Bioacoustics*, vol. 31, no. 3, pp. 241–260, 2022.
- [7] J. Guo, C. Jiang, and Y. Wang, "Exploring ecosystem responses to coastal exploitation and identifying their spatial determinants: Re-orienting ecosystem conservation strategies for landscape management[J]," *Ecological Indicators*, vol. 138, 2022.
- [8] W. Wang and W. Liu, "Environmental landscape design based on artificial intelligence and digital space technology[J]," *Journal of Electrical and Computer Engineering*, vol. 2022, Article ID 9955825, 2022.
- [9] M. Wild, S. Behm, C. Beck et al., "Mapping the time-varying spatial heterogeneity of temperature processes over the urban landscape of Augsburg, Germany," *Urban Climate*, vol. 43, Article ID 101160, 2022.
- [10] A. J. Nirmal, Z. Maliga, T. Vallius et al., "The spatial landscape of progression and immunoediting in primary melanoma at single cell resolution," *Cancer Discovery*, vol. 12, no. 6, pp. 1518–1541, 2022.
- [11] S. Timm, "The meanings of landscape: essays on place, space, environment and justice by kenneth R. Olwig (review)," *Environment, Space, Place*, vol. 13, no. 2, 2022.
- [12] C. He, K. Xiong, Y. Chi, S. Song, J. Fang, and S He, "Effects of landscape type change on spatial and temporal evolution of ecological assets in a karst plateau-mountain area," *International Journal of Environmental Research and Public Health*, vol. 19, no. 8, p. 4477, 2022.
- [13] W. Yang, B. Fan, J. Tan, J. Lin, and T. Shao, "The spatial perception and spatial feature of rural cultural landscape in the context of rural tourism," *Sustainability*, vol. 14, no. 7, p. 4370, 2022.
- [14] J. Foresti, R. R. Pereira, and P. A. Santana, "Spatial-temporal distribution of *Dalbulus maidis* (Hemiptera: Cicadellidae) and factors affecting its abundance in Brazil corn," *Pest Management Science*, pp. 78–76, 2022.
- [15] M.-G. Eduardo, B. Nilsson Mats, H. Laudon, and L. Tomas, "Overstorey dynamics regulate the spatial variability in forest-floor CO₂ fluxes across a managed boreal forest landscape[J]," *Agricultural and Forest Meteorology*, vol. 318, 2022.
- [16] Z. Yu, D. Song, Y. Song, S. K. Lau, and S Han, "Research on a visual thermal landscape model of underground space based on the spatial interpolation method—a case study in Shanghai," *Energy Reports*, vol. 8, no. S6, pp. 406–418, 2022.
- [17] Y. Hu, S. Yin, W. Xiao, B. Hou, and X Zhang, "Spatial scale effects of landscape patterns on water quality changes in drinking water source protection areas: a case study in the Guishui River Basin, China," *Arabian Journal of Geosciences*, vol. 15, no. 8, p. 685, 2022.
- [18] H. Wang, M. Zhang, C. Wang et al., "Spatial and temporal changes of landscape patterns and their effects on ecosystem services in the huaihe river basin, China," *Land*, vol. 11, no. 4, p. 513, 2022.
- [19] T. Y. Lau Tammy, J. S. D Zahra, and T Emma, "The neo-antigen landscape of the coding and noncoding cancer genome space," *The Journal of Molecular Diagnostics*, vol. 24, 2022.
- [20] S. M. Shadchinov, "Dependence of the normalized difference vegetation index level on the spatial structure of the landscape and its time variability using the example of the West end of the Crimean Peninsula (Tarkhankut Peninsula)," *Izvestiya - Atmospheric and Oceanic Physics*, vol. 57, no. 12, pp. 1586–1595, 2022.
- [21] G. Wu, Y. Miao, and F. Wang, "Intelligent design model of urban landscape space based on optimized BP neural network [J]," *Journal of Sensors*, vol. 2022, Article ID 9704287, 2022.
- [22] Y. Duan and S. Li, "Study of different vegetation types in green space landscape preference: comparison of environmental perception in winter and summer," *Sustainability*, vol. 14, no. 7, p. 3906, 2022.
- [23] J. Ai, K. Yu, Z. Zeng, and Y Liuqing, "Assessing the dynamic landscape ecological risk and its driving forces in an island city based on optimal spatial scales: Haitan Island, China[J]," *Ecological Indicators*, vol. 137, 2022.
- [24] W. Ren, J. Zhao, and X. Ma, "Analysis of the spatial characteristics of inhalable particulate matter concentrations under the influence of a three-dimensional landscape pattern in Xi'an, China[J]," *Sustainable Cities and Society*, vol. 81, 2022.
- [25] S. Schmidt, G. Paulina, and A. at al, "Advancing Sustainable Development Goals with localised nature-based solutions: opportunity spaces in the Lahn river landscape, Germany[J]," *Journal of Environmental Management*, vol. 309, 2022.
- [26] Q. Seth, A. Dolly, D Stephanie, and H Jennifer, "Tracking emergent spatial and social patterns across terraced landscapes in polynesia[J]," *Journal of Field Archaeology*, vol. 47, no. 3, 2022.

Retraction

Retracted: A Study of the Morphological Design of Architecture from a Geometric Logic Perspective

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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] L. Zhao and Y. Yang, "A Study of the Morphological Design of Architecture from a Geometric Logic Perspective," *Security and Communication Networks*, vol. 2022, Article ID 8140350, 11 pages, 2022.

Research Article

A Study of the Morphological Design of Architecture from a Geometric Logic Perspective

Liuzhen Zhao and Yingli Yang 

Hebei University of Water Resources and Electric Engineering, Cangzhou 061000, Hebei, China

Correspondence should be addressed to Yingli Yang; yangyingli@hbwe.edu.cn

Received 17 June 2022; Revised 20 July 2022; Accepted 1 August 2022; Published 29 August 2022

Academic Editor: Tao Cui

Copyright © 2022 Liuzhen Zhao and Yingli Yang. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

In order to further solve the problem of the application and auxiliary function of geometric prototypes in the process of complex architectural structural form design, a method of architectural form design research based on the perspective of geometric logic is proposed. Taking buildings as an example, combined with the requirements of architectural form design, the optimal design of architectural structure form is studied with the help of genetic algorithm, focusing on the verification of building plane and space optimization design under displacement constraints. The results show that after 3257 iterations, the adaptive degree does not change, the corresponding maximum uniqueness is 0.1196 mm, and the weight of the truss structure is 0.3585 t, indicating that the structural design based on geometric logic and genetic algorithm can effectively satisfy the optimal form design of the building form under the constraints. The design method of geometric logic incorporates the whole process of building use, building site, building system, and production and construction into the control scope of the design. In the design process, according to the real environment, through the translation and logic construction of computer language simulation, the architectural concept scheme is generated, and finally the building product is promoted. Complete with high precision.

1. Introduction

In recent years, with the continuous development of the construction industry and the progress of science and technology, the construction industry has undergone profound changes based on the improvement of digital technology, artificial intelligence technology, and construction technology [1]. Advanced parametric design tools and powerful computing advantages of computer technology provide a certain technical support for the innovative development of the construction industry and the innovative design of architectural forms. With the support of these technologies, modern architecture even began to surpass the traditional architectural form, and the connotation and extension of modern architectural form design have been extended to a certain extent. With the aid of parametric design tools and geometric logic principles, more and more complex buildings began to appear, and the innovation of architectural form design was incisively and vividly reflected.

The architectural industry has put forward higher requirements for the design, the rationality of the architectural form, and the possibility of use and correlation. The architectural design is no longer subject to the constraints and constraints of traditional geometric principles, and the modern architectural form under the perspective of geometric logic more and more meet people's demand for high-quality buildings [2].

2. Literature Review

Architectural geometry emerges as architecture enters the digital era. It is theoretically influenced by advanced geometry theories such as differential geometry, topology geometry, fractal geometry, and cellular automata. It mainly focuses on the design and analysis of complex public building forms and the application research of construction process. The research content includes free-form surface creation of architectural form, discrete generative design of

surface, digital prototype manufacturing, and so on, which mainly plays a role in the optimization control of architectural form and surface. With the development of society, the emergence of complex buildings, the continuous progress of parametric building technology, and the emergence of digital virtual technology have narrowed the distance between people and the future space [3]. However, no matter how extensive such expansion is, it cannot change the materiality of architecture as an object existing in space. This materiality carries the hard and intelligent work of temperature technology from generation to generation. To continue to adhere to it is to adhere to the belief that architecture is the cultural foundation [4].

The research on the application of geometric logic in architectural design thinking and architectural form control in China mainly focuses on the study of architectural form design or construction methods based on geometry or advanced geometry. The main research directions are the application of topology in contemporary architectural form and space creation; research on architectural geometric logic control based on engineering practice; research on the generation and construction of complex architectural forms based on advanced geometry; and complex architectural form control based on geometric logic. This part of the research is mainly based on the use of geometric control system method, the control and optimization method of architectural form is discussed, and the research is based on engineering practice and project practice, and has high research value [5]. In the research of parametric design digital construction based on geometric logic thinking, on the one hand, it is aimed at parametric technology or digital construction technology, and the geometric logic construction method of architectural form, such as the geometric logic construction method of architectural form based on parametric technology and research on geometric construction strategy of contemporary digital architecture [6]. On the other hand, the research on the application of parametric method to the generation of architectural design scheme also includes the research on the operation process of digital technology based on a certain relationship [7]. After entering the twenty-first century, the geometric form of architecture develops from linear geometric form to more free-stretching nonlinear geometric form. The transformative appearance of parametric nonlinear design method makes the geometric form of this period a comprehensive product based on the analysis of the real environment and real performance requirements of the building. The geometric logic design method brings the whole process of building site construction system and production and construction into the control scope of the design. In the design process, based on the real environment, the architectural concept scheme is generated through the translation and logical construction of computer language simulation. In the deepening and construction links, precise geometric modules are used to control the control drawings and samples of each datum, and finally promote the high-precision completion of architectural products. It is such digital transformation that once again promotes the relationship between architecture and geometry, thus triggering the transformation of geometric logic thinking in architectural design [8].

3. Architectural Structural Form Design Based on Genetic Algorithm

As a typical algorithm in modern optimization algorithms, genetic algorithm, compared with mathematical programming method and optimal criterion method, has the advantages of high efficiency, strong robustness, and strong global optimization ability, and can more effectively search for structural optimization by simulating the natural evolution process. However, the traditional genetic algorithm is prone to premature convergence in the iterative process, oscillation around the optimal solution when it is approaching the optimal solution, and large randomness. The factors that need to be considered in the design of building structures are becoming more and more important. The more complex traditional genetic design methods are often difficult to handle. Therefore, in order to avoid the traditional genetic algorithm falling into the local optimal solution prematurely, this paper improves the traditional genetic algorithm from the two aspects of fitness value function calibration and population diversification, broadens the optimization space of the genetic algorithm, and uses the improved genetic algorithm. The algorithm solves the optimization problem with discrete variables of structural section size and stress constraints, which provides a new idea for scientific structural design optimization.

3.1. Principle of Genetic Algorithm in Shape Design

3.1.1. Operating Principle. The operation of genetic algorithm is divided into three elements of coding fitness function and genetic operation, which work alternately in coding space and decoding space. The genetic operation of chromosomes is completed in the coding space, while the discrimination and selection of solutions are carried out in the solution space, as shown in Figure 1. The whole genetic algorithm is to use coding and decoding to connect the coding space and solution space, work in a continuous cycle, and finally search out the optimal results in the solution space [9, 10].

Feasibility refers to whether the solution obtained after chromosome decoding is contained in the range of the solution. If the solution is within the range, it indicates that the solution is feasible. If it is not within the range, the results obtained are not feasible. Legitimacy refers to whether the obtained chromosomes can represent the solution of the problem, as shown in Figure 2.

3.1.2. Fitness Function. The general fitness function has the following three transformations:

The first is to directly use the objective function as the fitness function:

The biggest problem with objective functions:

$$\text{Fit}(f(x)) = f(). \quad (1)$$

Minimum objective function problem:

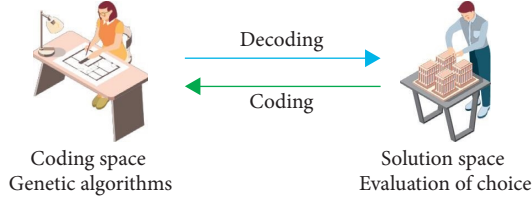


FIGURE 1: How genetic algorithms work.

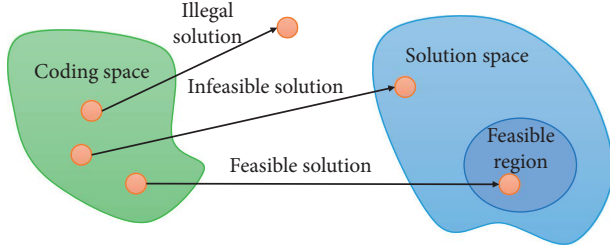


FIGURE 2: The feasibility and validity of the solution.

$$\text{Fit}(f(x)) = -f(x). \quad (2)$$

The advantage of this method is that it is more intuitive and simple, and easy to understand, but the disadvantage is that it cannot meet the non-negative conditions of some selection methods, and when solving some function problems, the value difference is too large, which hinders the average performance.

Second is boundary construction method.

To minimize the objective function:

$$\text{Fit}(f(x)) = \begin{cases} c_{\max} - f(x), & f(x) < c_{\max}, \\ 0, & \text{others,} \end{cases} \quad (3)$$

c_{\max} is an estimated large number of $f(x)$.

If we find the maximum problem of the objective function,

$$\text{Fit}(f(x)) = \begin{cases} f(x) - c_{\min}, & f(x) > c_{\min}, \\ 0, & \text{others,} \end{cases} \quad (4)$$

c_{\min} is an estimated decimal of $f(x)$.

To minimize the objective function:

$$\text{Fit}(f(x)) = \frac{1}{1 + c + f(x)}, \quad c \geq 0, c + f(x) \geq 0. \quad (5)$$

If you want to maximize the objective function,

$$\text{Fit}(f(x)) = \frac{1}{1 + c - f(x)}, \quad c \geq 0, c - f(x) \geq 0. \quad (6)$$

This method is an improvement of the second method, and c estimates the bounds of the objective function.

3.1.3. Genetic Operator Operation. Among all crossover operators, the most common is single-point crossover, which means that there is only one crossover point. Genes at the intersection of two paired chromosomes are exchanged and recombined to form new chromosomes in three steps:

- (1) Pairwise selection of the population operated by crossover operator is generally random, but also can be selected sequentially.
- (2) After the pairing was completed, a random crossover point was formed for each pair of chromosomes, and the crossover point was located between loci [11, 12].
- (3) The genes behind the intersection of two paired chromosomes are swapped and recombined according to the location of the intersection, so that two new chromosomes are created such that one pair of paired chromosomes in a population is

$$\begin{aligned} C_1: & 10011001|11, \\ C_2: & 01001111|00. \end{aligned} \quad (7)$$

Including | for cross-position will be crossed off the gene behind two chromosomes' intersection after restructuring and get two new chromosomes:

$$\begin{aligned} C'_1: & 10011001|11, \\ C'_2: & 01001111|11. \end{aligned} \quad (8)$$

The advantage of using single-point crossover is that if individual traits or fitness is provided by continuous loci, single-point crossover can greatly reduce the probability of breaking such continuity, which is beneficial to the convergence and efficiency of genetic algorithm. In the operation of genetic algorithm, the main parameters mainly include chromosome encoding length L , population size M , crossover probability p_c , mutation probability p_m , termination algebra T , and so on. Termination algebra is only one of the termination conditions of genetic algorithm. It can also determine whether to terminate genetic algorithm according to the convergence after each iteration [13, 14].

3.2. Procedure of Algorithm.

- (1) The total population of chromosomes was randomly generated, and fitness calculation was carried out. According to the selection probability, chromosomes with better fitness were selected from the total population as the parent of the first iteration, and chromosomes with poor fitness were selected as the backup pool, as shown in Figure 3.
- (2) Parent generation pairs are paired to perform crossover operator operation to generate offspring chromosomes, and the fitness of offspring is calculated. Parent generation 1 is selected according to the fitness to perform mutation operator operation, as shown in Figure 4.
- (3) Parent 1 operates the mutation operator according to the coefficient of variation to generate offspring 1 and calculate the fitness. By comparing with parent 1 and backup pool 1, chromosomes with better fitness are selected as the mother of the next iteration, as shown in Figure 5.

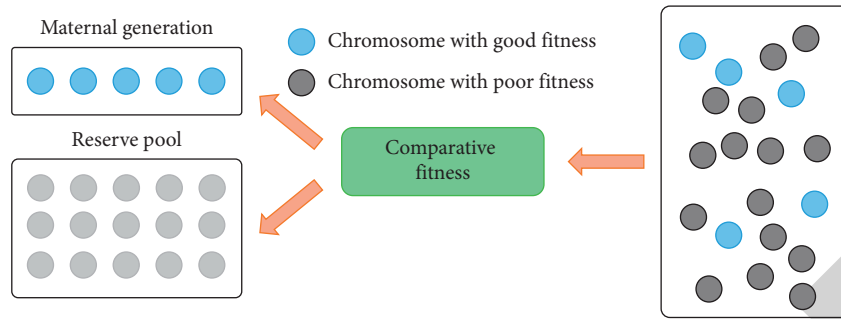


FIGURE 3: Selection operator operation.

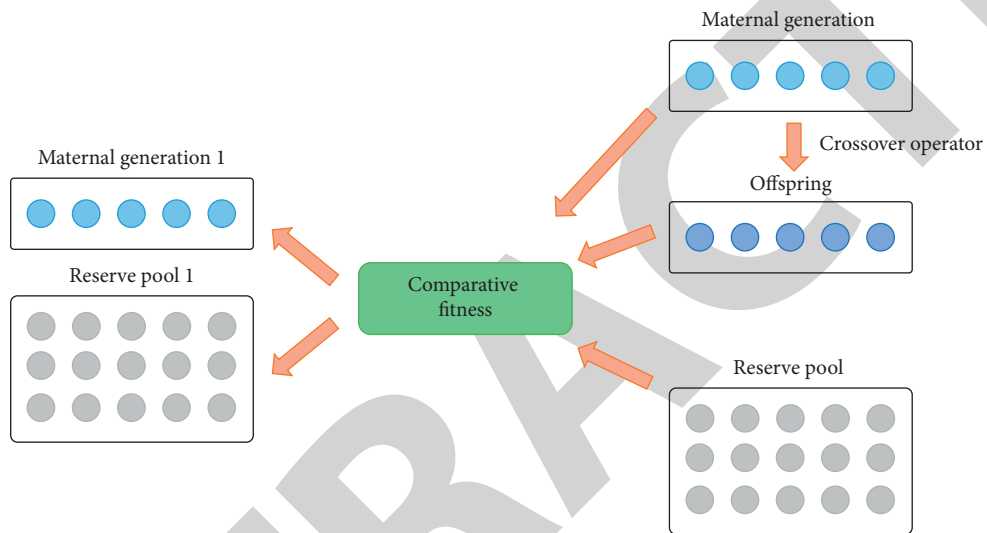


FIGURE 4: Crossover operator.

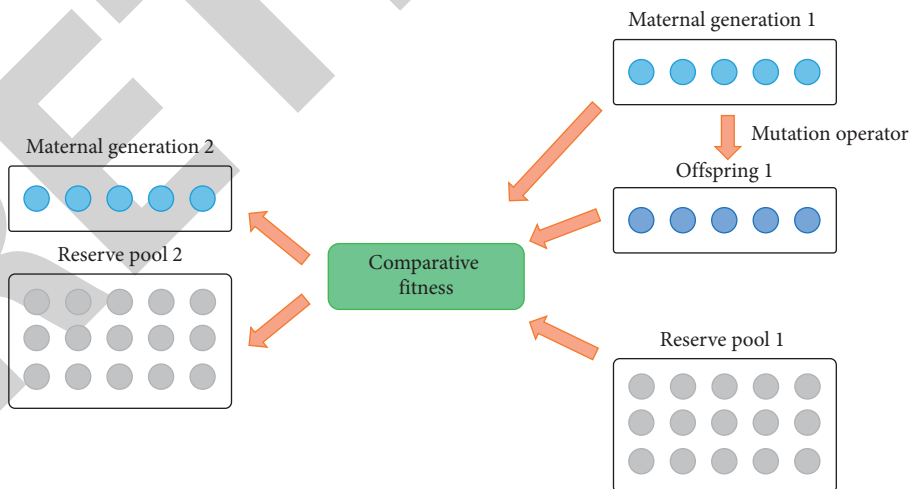


FIGURE 5: Mutation operator operation.

The operation of genetic algorithm is mainly accomplished by selection operator, crossover operator, mutation operator, and fitness calculation. After the completion of each genetic operation, the fitness was

calculated and sorted by comparison, and the individuals with better fitness were retained for the next genetic operation [15, 16]. Figure 6 shows the flow of genetic algorithm.

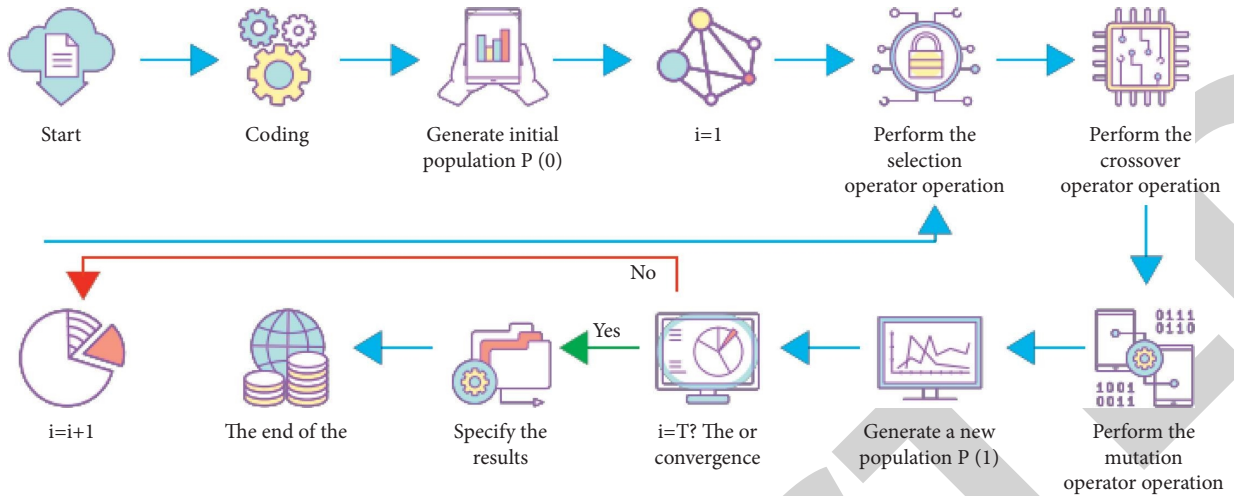


FIGURE 6: Genetic algorithm flowchart.

3.3. *Function Evaluation.* The real solution x is converted to a binary number, and the binary 0–1 string formed is used as the chromosome 0–1 string for genetic algorithm. The length of the binary 0–1 string depends on the accuracy of the function solution. For example, in the range $[0, 1]$, the precision is 0.001, then the binary 0–1 string length is 10 assuming that one of the solutions is 0.305, and then it is represented by binary:

$$C: (0100110111). \quad (9)$$

To convert the binary 0–1 string obtained after the operation of the genetic algorithm into the corresponding real number, the decimal value of the binary 0–1 string needs to be calculated first. For example, the binary 0–1 string D in $[C, D]$ is as follows:

$$D: (a_1 a_2 a_3 a_4 a_5 a_6 a_7 a_8 a_9 a_{10}). \quad (10)$$

Convert it to a base 10 number:

$$x = \left(\sum_{i=0}^9 a_i \cdot 2^i \right)_{10} \quad (11)$$

$$= (a_1 a_2 a_3 a_4 a_5 a_6 a_7 a_8 a_9 a_{10})_2.$$

Then, x corresponds to the real numbers of $[c, d]$:

$$x_1 + c + x \cdot \frac{d - c}{2^{10} - 1}. \quad (12)$$

For example, a code string $C: (0011110110)$ with 0.001 precision in $[0.1]$ represents a real number of 0.246.

Based on the accuracy, we can determine that the length of chromosome coding string is 10 and randomly generate 50 binary coding strings to form the initial population, minus Table 1 [17, 18]. After fitness comparison, 10 chromosomes were selected proportionally for genetic algorithm operation iteration process, as shown in Figure 7.

It can be seen from Figure 7 that the fitness increases with the number of iterations and does not increase after reaching a certain point. In this case, the optimal solution is

TABLE 1: Iterative process.

Iterations	Binary coding	X	Fitness
Step 1	0 1 0 0 1 1 0 0 1 0	0.307	-0.786491
Step 3	1 0 0 1 1 1 1 1 1 0	0.506	-0.750033
Step 9	0 0 0 1 1 1 1 1 1 0	0.504	-0.750012
Step 10	1 1 1 0 1 1 1 1 1 0	0.502	-0.750008
Step 11	0 1 1 0 1 1 1 1 1 0	0.501	-0.750003
Step 16	0 1 1 1 1 1 0 1 0 0	0.500	-0.750001

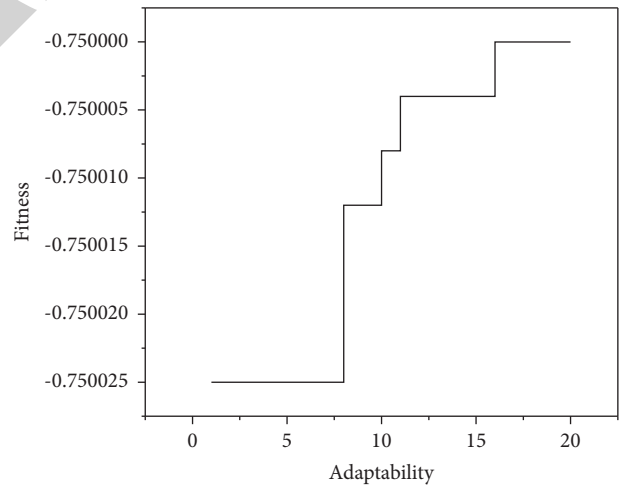


FIGURE 7: Fitness iteration polyline.

(0 1 1 1 1 1 0 1 0 00), which is converted into a real number of 0.500, and the maximum value of the function is -0.750000.

When the genetic algorithm iterates to the 118th generation, the result obtained is the optimal solution. Figure 8 shows the broken line of the relationship between fitness and iteration times. It can be seen that fitness decreases with the increase of iteration and does not decrease after reaching a certain value[19, 20]. See Figure 8.

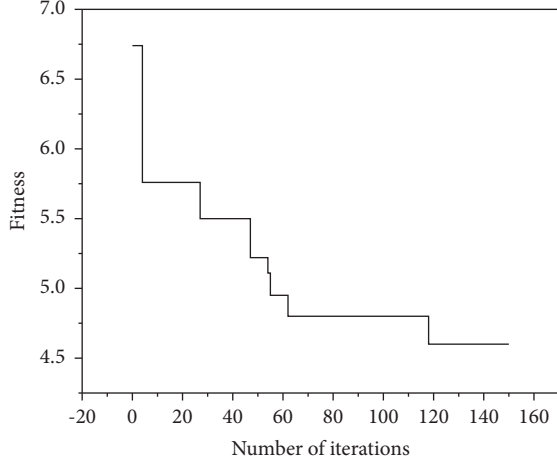


FIGURE 8: Fitness iteration polyline.

3.4. Algorithm Example. Taking truss structure optimization as an example, the three variables that have great influence on the mechanical properties of the truss structure, namely, the topological form of the truss and the truss shape and the cross-sectional area of the members, are operated by genetic algorithm. The problem can be expressed by the following mathematical model:

$$\begin{cases} \min, & \text{fitness}(x) = \frac{1.0}{D_{\max} * W}, \\ & s \in \Omega, \\ \text{s.t.}, & A \in A_0, \end{cases} \quad (13)$$

x is the topological relation of the structure, the cross-sectional area, and the coordinates of the nodes and other variables, D_{\max} is the maximum displacement of the structure, W is the weight of the structure, s is the shape of the structure, Ω is the spatial condition, indicating that the node position should be within the spatial range of the constraint, A is the cross-sectional area, and A_0 is the cross-sectional area condition indicating that the selected cross-sectional area type should restrict the cross-sectional area range.

The shape design under constraint conditions is to meet certain constraints such as displacement and internal force and carry out topology and shape design of the structure [21, 22]. The research focuses on the optimization of truss structure shape under displacement constraints, as shown in Figure 9, where the precision instrument is placed on the structure. The structure produces vertical displacement due to the weight of the precision instrument itself. In order to ensure the accuracy of the measurement of the precision instrument, the vertical displacement of the upper surface of the structure is required to be equal.

The three nodes in the middle of the lower chord in the figure are taken as variables. It is required that all nodes of the upper chord have the same vertical displacement under the gravity of the precision instrument. The following mathematical model can be used to represent this kind of problem:

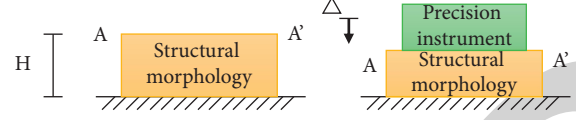


FIGURE 9: Deformation diagram.

$$\begin{cases} \min & \text{fitness}(x) = \frac{\sum_{i=1}^n (\Delta y_i - \bar{u})^2}{n}, \\ \text{s.t.} & s \in \Omega. \end{cases} \quad (14)$$

As shown in Figure 10(a) and 10(b), the topological form of the truss has been given, wherein the ordinate of node 6 is changeable, and point 1 is used as the origin of the coordinate, so the range of ordinate variation of point 6 is [0, 1], with a precision of 0.001. Point 1 and point 5 are hinge supports, and a vertical load of 1 kN is applied at points 2, 3, and 4, respectively. The cross-sectional area of the rods is 2.5 cm², requiring that the vertical displacement of the joints of the upper chord of the truss is basically the same. As the vertical displacement of the nodes of the upper chord of the truss is required to be equal, the fitness is selected as the displacement variance, the initial population is 50 chromosomes, the selection probability is 20%, and the mutation probability is 0.01. After genetic algorithm iteration, the results are as follows:

As can be seen from the figure above and Table 2, when the genetic algorithm iterates to the 11th time, the ordinate of point 6 is the optimal solution that meets the constraint conditions, which is 0.486.

As the vertical displacements of the nodes of the upper chord of the truss are required to be equal, the fitness is selected as the variance of the vertical displacements of the three nodes. The initial population is 100 chromosomes, the selection probability is 20%, and the mutation probability is 0.01. After genetic algorithm iteration, the results are shown in Figure 11(a) and 11(b).

It can be seen from the figure that as the number of iterations increases, the truss form obtained changes constantly. When the iteration reaches the 1026 generation, the optimal result is obtained, as shown in Tables 3 and 4.

It can be seen from the above table that when the genetic algorithm iterates to the 1026 generation, the displacement variance between points 3, 4, and 5 is the smallest, and it can be considered that the vertical displacement of the three nodes is equal. As the number of iterations increases, the fitness also increases, and it stops changing when it reaches a certain value. In the figure, when the iteration reaches the 3257 generation, the fitness does not change. The maximum displacement of the final truss form obtained by iteration is 0.1196 mm, and the weight of the truss is 0.3585 t.

4. Architectural Form Design under Geometric Logic

4.1. Factors Influencing the Formation of Complex Architectural Structure Form. There are some complex form buildings, the structure is separated from the external form,

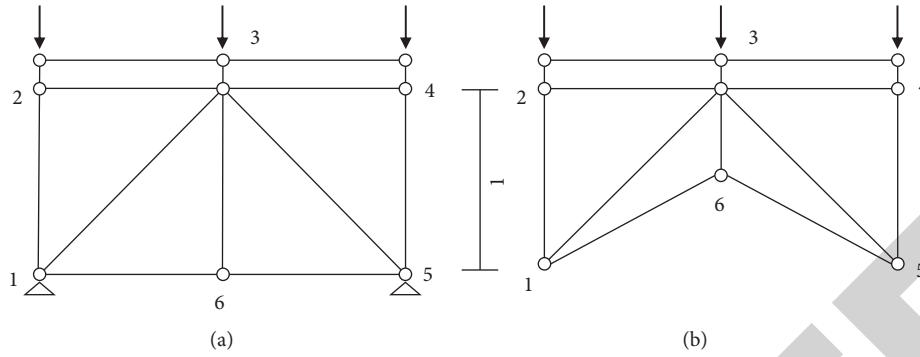


FIGURE 10: Truss optimization under constraint conditions. (a) Initial conditions. (b) Final shape.

TABLE 2: Iterative process.

Step	Fitness	Y_3
Step 1	2.513E-07	0.497
Step 5	2.049E-07	0.495
Step 11	3.891E-07	0.486

but it is not that the structure does not conform to the logic of building form generation, but because the building is a very large and complicated system, sometimes in order to achieve different purposes, the structure and form system can also be divided into two corners, and the structure can also be divided into different function systems. Some buildings are complex in shape, but the internal function layout is still in accordance with the traditional floor setting room division. In this case, the structural system of the building can be divided into several parts according to the actual demand, and the structural part most closely related to the shape is obtained by the shape generation logic. The more orderly part of the interior can adopt the simple structure of the traditional beam, plate, and column system. The targeted scheme avoids unnecessary economic losses caused by the complexity of simple problems. For example, in the super high-rise China Respect Project, the central square core tube is a simple part of the whole structural system, while the periphery (the four corners of the square plane) is a complex part of the structure, such as the giant column system and the waist truss system, which change with the change of the building form [23, 24].

4.1.1. Structural Mechanical Factor. The safety, applicability, and durability of structures are directly related to their mechanical properties, so mechanical factors become the primary consideration for the realization of structures. Generally speaking, complex building structural systems have unique mechanical characteristics to meet the realization of complex forms. It can distribute its load and stress effectively to the whole structure system. From the principle of structural mechanics, the structural system can evenly transfer the load, which indicates that it has high efficiency. Therefore, the complex structural system itself has quite high mechanical rationality, which is more in line with the construction logic than the traditional beam, plate, and column system.

Optimization can be divided into two aspects, due to structural optimization, take the form as the optimization variable, adopt the appropriate optimization algorithm, and get the optimal form, this method is also known as the numerical method of creating form, because it involves a lot of expertise in structural engineering.

On the other hand, the finite element software ANSYS and structural design software PKPM are used to analyze and optimize the structural component system after the building surface shape is determined under the influence of structural indicators. The main aspects of the study are static analysis, modal analysis, and buckling analysis, and the secondary components of the structure are tested and analyzed to obtain the optimal solution of its mechanical properties.

4.1.2. Structural and Functional Factor. Under certain circumstances, the establishment of the structural system can provide an interrelated dynamic system for the crowd movement trend function configuration space characteristics; for example, the linear setting of the structure can determine the single path of the crowd flow line. The scale and transparency of the space established by the structure can provide specific modes of behavior or spatial use. This correlation is not only limited to complex structure, but also reflected in the traditional structure, but complex structure can be deduced form the more thoroughly clear. Especially after using the parameterized technology, integration of the behavior of the feature space, and the intelligent programming language through algorithm, such as demand, structure of system becomes more diversified, more relevant, and functional use.

The influence of function on the integration of structure is also reflected in the direct integration of the two. In the process of diversified development of architecture, the boundary between the structural skin and the room has become increasingly blurred. Sometimes, the structure is a functional space, and the space is also reflected by the structure. For example, Toyo ITO Sendai Media Center's design concept is a completely free system of behavior, and no room division, through the beamless floor and seaweed light columns to reflect the structure. These hollow structural columns are cleverly designed as stairwells, elevators,

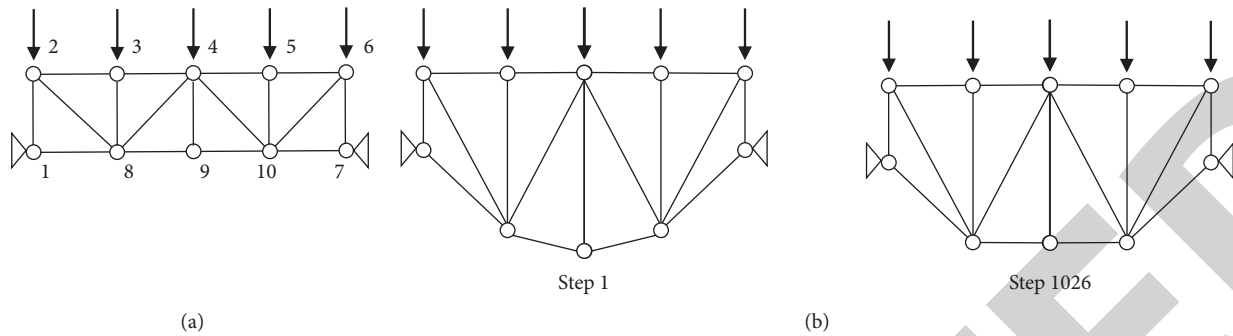


FIGURE 11: Truss optimization under constraint conditions. (a) Initial conditions. (b) Final shape.

TABLE 3: Change the coordinates of the nodes.

Iterations	Fitness	8-point ordinate	Nine-point ordinate	Ten-point ordinate
1	1.28E-11	0.59561	0.44943	0.57552
3	6.37E-12	1.24593	0.3582	1.24592
15	4.63E-13	1.0046	0.98342	1.0045
74	4.43E-13	0.85409	0.87443	0.85383
133	3.90E-15	0.40721	0.53047	0.40782
218	5.46E-17	1.21322	1.11779	1.21314
344	2.69E-19	0.82483	0.85166	0.82448
548	2.51E-19	0.91055	0.91117	0.91051
1026	2.12E-21	0.91256	0.91254	0.91224

TABLE 4: Constrain the displacement of the node.

Iterations	Fitness	4-point displacement	4-point displacement	5-point displacement
1	1.28E-11	-2.1775277E-04	-2.1879394E-04	-2.1367026E-04
3	6.37E-12	-1.9874904E-04	-1.9948945E-04	-1.9870909E-04
15	4.63E-13	-1.2137348E-04	-1.2191081E-04	-1.2137351E-04
74	4.43E-13	-1.1954922E-04	-1.2008521E-04	-1.1959555E-04
133	3.90E-15	-1.2437863E-04	-1.2442926E-04	-1.2439288E-04
218	5.46E-17	-1.2965421E-04	-1.2964772E-04	-1.2965318E-04
344	2.69E-19	-1.1929033E-04	-1.1929005E-04	-1.1929033E-04
548	2.51E-19	-1.1973768E-04	-1.19737798E-04	-1.1973766E-04
1026	2.12E-21	-1.1975644E-04	-1.1975644E-04	-1.1965744E-04

equipment, pipes, and small rest spaces due to their appropriate space accommodation, thus achieving a high degree of integration of structure and function.

4.2. Geometric Logic in Architectural Structural Form Design

4.2.1. Selective Construction Starting Point. From the perspective of thinking method, parametric geometric logic construction is guided by nonlinear thinking method, which advocates flexibility and uncertainty of design process and opposes solidification and stylization of thinking activities. Therefore, parametric geometric logic construction advocates constructors to enter the work of geometric logic construction in different ways. In the process of design, through updating and reconstruction, they can deepen their knowledge and understanding of the

design environment and gradually reach a balance state with the design constraints. However, there are many complexities in architectural design. In the initial stage, parameterized geometric logic construction should make design objectives and thoroughly analyze the relationship between various parameters and the environment. Thus, instead of the traditional top-down approach, the construction starts with one or several distinct geometric logics.

4.2.2. Select Parameters. In the process of constructing parameterized logic, it is very necessary to optimize the selection of variables. Only by selecting the correct parameters, can the parameterized geometric model be controlled in the best way. Generally speaking, the parameters should be selected to meet

the requirements of architectural form control precision as the basic conditions, and the number of parameters should be set in accordance with the principle of less to more on this basis and tries to set the parameters in the initial stage of geometric logic construction and reduce the parameter adjustment in the construction process. In the design, the architect first performs a logical analysis of the target geometry and draws a logical framework on the computer, then writes a script and debugs it. Debugging is an important part of programming and is the most common solution architects use when logical relationships are unclear. Debugging can not only verify the correctness of the program function, but also provide inspiration and enlightenment to the constructor in the process of solving mistakes. It is a dynamic feedback process. In addition, the geometric form of architectural form usually has some relatively stable topological structure and internal laws. Architects can also rely on mature algorithms or functions to carry out parametric construction work, such as using existing functions in MATLAB and Mathematica to directly generate hyperboloid minimal surface. In a word, the process of finding logical relations and establishing models in parametric geometric logic construction can be illustrated in Figure 12.

4.2.3. Output. Theoretically, the process of parametric geometric logic construction is finished after the parametric model is obtained, but in practical work, the parametric model is not the real result required by architects, and it needs to be further output as a solid model for subsequent work such as rendering, animation, and 3D printing. For projects that need to be built and implemented, parameterized software not only needs to provide the building model to the manufacturer, but also needs to provide the management database of all production components synchronously, including naming rules, positioning parameters, and material attributes. The output of the result is the last step of the construction of parametric geometric logic and also the key link of transforming the construction of parametric geometric logic from thinking consciousness to material form. At present, the file output formats of various parametric software and digital manufacturing software are not unified. Architects often need to convert file formats among various software. Generally speaking, file formats with small storage space have good compatibility, but the model accuracy is not enough, and it is easy to lose information. File formats with high accuracy are perfect for the storage of various information of parameter models, but occupy a large space and process slowly. Therefore, architects need to consider the output of results in the initial stage of geometric logic construction. Currently, the commonly used output formats are 3 ds file, igs file, obj file, and so on.

4.2.4. The Combination of Parametric Design and Construction Techniques. The construction method of parametric geometric logic can be summarized as the following six steps:

- a) Find the internal law
 - b) Formation law
 - c) Using parametric tools to transform the law into computer program
 - d) Debugging program
 - e) Result feedback
 - f) Program optimization
 - g)
 - h) The ideal parameter model is obtained
- } Repeat cycle steps (d) - (g)

FIGURE 12: The process of finding logical relationships and building models.

- (5) The combination of parametric design and local construction techniques.

Parametric geometric logic construction method has strong adaptability and can provide parametric solutions in different regions and different ideologies. It is an effective innovation approach for northern Xinjiang. But under the strong and accurate control of parametric geometry construction, to achieve a short time of fine construction requires the cooperation of high-precision CNC equipment, which is not consistent with the construction truth in Xinjiang [25]. Therefore, it is necessary to combine parametric geometric construction with low-tech technical construction in the later stage. At the beginning of the design, the convenience of artificial construction and the use of low-tech strategy should be considered, and local technologies and materials should be used according to local conditions. Improve the readability of drawings, and interpret the construction of each detail to workers by using construction manuals with a large number of 3D detail model disassembly at the construction site. At the same time, we pay attention to the decomposition and simplification of difficult problems, and give each project participant the most simple and clear task, so as to achieve comprehensive overall and efficient control.

5. Conclusion

In the context of nonlinear and complex architecture, geometry has become an indispensable tool in the design and construction of buildings. On the one hand, the architecture makes use of advanced geometry principles to generate rich algorithms and mathematical models in the generative logic. On the other hand, geometry, as a practical tool, deals with the referential meaning of geometric symbols, the complex relationship between geometric figures and the exact size. It should be pointed out that in the whole process of realizing the structural system of the base control surface and the skin system, the architectural form control is in a process of constant optimization considering many variables and complex factors. Therefore, the construction of geometric control system is a precise control of the architectural system. More accurately, it is a process of finding the optimal solution that is most suitable for the material and spiritual context of the building in the process of constantly running

in with diversified systems such as culture, aesthetics, environment, ecological structure, and material structure. From the perspective of architectural shape design requirements, this study focuses on the key points of architectural structure shape design with the help of genetic algorithm and geometric logic. The results show that, after 3257 iterations, the fitness does not change, the corresponding maximum is only 0.1196mm, and the weight of truss structure is 0.3585t. It shows the structure design based on geometric logic and genetic algorithm. It can effectively meet the constraints of the architectural shape optimization design. The application of geometric logic should be the stage of controlling the design from the whole system and the whole construction system, which makes the realization process of complex form architecture become an interlocking and efficient docking process. Because of the materiality of architecture, it is not a beautiful idea but a functional space that needs to be put into practice. Therefore, in the whole design and construction process, it is restricted by the actual space construction technology, material characteristics, structural means, and many other aspects. This paper first uses advanced geometric principles to generate rich algorithms and mathematical models, and then improves the traditional genetic algorithm in terms of fitness value function calibration and population diversification. Convergence, low precision, large randomness, and other problems are applied to the optimization design of building structures, the application of geometric logic can better meet the actual needs of building structure optimization engineering, the practicability has been greatly improved, and it has scientific reference value.

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

This work was supported by the Hebei University of Water Resources and Electric Engineering.

References

- [1] C. You, "Research on the architectural culture of jiarong Tibetan in northwest sichuan from the perspective of architectural anthropology," *Open Access Library Journal*, vol. 7, no. 8, pp. 1-7, 2020.
- [2] Y. Yang, "An analysis of hazel notes in wise blood from the perspective of p," *Journal of Higher Education Research*, vol. 3, no. 2, pp. 188-190, 2022.
- [3] X. Ren, C. Li, X. Ma et al., "Design of multi-information fusion based intelligent electrical fire detection system for green buildings," *Sustainability*, vol. 13, no. 6, p. 3405, 2021.
- [4] B. Olgen, "A literature review on the use of music in architectural design education," *International Journal of Technology and Design Education*, vol. 25, no. 2, pp. 74-88, 2020.
- [5] W. X. Peng, M. K. Xu, Y. F. Chen, Z. H. Chen, and Z. Yang, "Field experiment research of the polycystic aeration bolt: model design and anchorage mechanism," *Advances in Civil Engineering*, vol. 2021, no. 6, 10 pages, Article ID 6669368, 2021.
- [6] J. Jayakumar, B. Nagaraj, S. Chacko, and P. Ajay, "Conceptual implementation of artificial intelligent based E-mobility controller in smart city environment," *Wireless Communications and Mobile Computing*, vol. 2021, Article ID 5325116, 8 pages, 2021.
- [7] B. N. Sandaker, B. Kleven, and A. R. Wang, "Structural typologies and the architectural space-studies of the relationship between structure and space by application of structural types to multistory buildings," *Architecture, Structures and Construction*, vol. 2, no. 1, pp. 199-221, 2022.
- [8] X. Liu, C. Ma, and C. Yang, "Power station flue gas desulfurization system based on automatic online monitoring platform," *Journal of Digital Information Management*, vol. 13, no. 6, pp. 480-488, 2015.
- [9] S. Anu, K. Muthukkumaran, M. Punniyamoorthy, S. A. Veerapandian, and G. Sangeetha, "A methodology for the transformation of architectural forms into music and vice-versa for the enhancement of the musical and architectural libraries," *Multimedia Tools and Applications*, vol. 80, no. 7, Article ID 10901, 2021.
- [10] K. Solanki, "Understanding the integration of construction techniques in the architectural design process by assessing Catalan vaulting structures," *Masonry International*, vol. 33, no. 1, pp. 15-26, 2020.
- [11] R. Huang, S. Zhang, W. Zhang, and X. Yang, "Progress of zinc oxide-based nanocomposites in the textile industry," *IET Collaborative Intelligent Manufacturing*, vol. 3, no. 3, pp. 281-289, 2021.
- [12] M. A. Kamal, A. Setya, and T. S. Brar, "Exploration of catenary based ferrocement shell structures: form, design and architectural interventions," *Architecture Research*, vol. 10, no. 4, pp. 93-101, 2020.
- [13] H. Zhao and H. Meng, "Research on the connotation and development strategy of Chinese campus football culture from the perspective of the integration of sports and education," *Open Journal of Social Sciences*, vol. 9, no. 3, pp. 157-163, 2021.
- [14] Z. Guo and Z. Xiao, "Research on online calibration of lidar and camera for intelligent connected vehicles based on depth-edge matching," *Nonlinear Engineering*, vol. 10, no. 1, pp. 469-476, 2021.
- [15] Q. Wang and S. Liu, "Research on the development path of domestic tourism characteristic towns from the perspective of integration of culture and tourism," *Open Journal of Social Sciences*, vol. 9, no. 1, pp. 234-242, 2021.
- [16] J. Zhang, Q. Zou, K. Zhang, and X. Gao, "Research on cross-boundary invitational learning model for pre-service science teachers: from the perspective of self-determination theory," *Open Journal of Social Sciences*, vol. 9, no. 4, pp. 1-15, 2021.
- [17] X. Wei, "Research on the health of senior citizens from an interdisciplinary perspective: framework, core topics, and prospects," *China Population and Development Studies*, vol. 5, no. 4, pp. 345-362, 2021.
- [18] T. Ma, Y. Liu, D. Yang, Z. Zhang, X. Wang, and S. Hao, "Research on the design of smart morphing long-endurance uavs," *Aeronautical Journal*, vol. 125, no. 1283, pp. 22-41, 2020.

Retraction

Retracted: Data File Security Strategy and Implementation Based on Fuzzy Control Algorithm

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. Ren, "Data File Security Strategy and Implementation Based on Fuzzy Control Algorithm," *Security and Communication Networks*, vol. 2022, Article ID 2010419, 10 pages, 2022.

Research Article

Data File Security Strategy and Implementation Based on Fuzzy Control Algorithm

Jin Ren 

Department of Network Security, Henan Police College, Zhengzhou, Henan 450046, China

Correspondence should be addressed to Jin Ren; rj5730@hnp.edu.cn

Received 30 May 2022; Revised 28 June 2022; Accepted 11 July 2022; Published 29 August 2022

Academic Editor: Tao Cui

Copyright © 2022 Jin Ren. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Today there are few studies on data file security strategies, but with the increase in information technology, the more the security of data files cannot be ignored. In this paper, based on the research of data file security policy, a model of data file security interaction based on a fuzzy control algorithm is proposed, and the correct rate of the model proposed in this paper is improved by about 1.5% under the traditional FTP server-based model.

1. Introduction

In today's information era, the use of computers has greatly facilitated people's lives and changed their office and communication methods. Computer data security refers to the adoption of certain technical measures to provide shelter and security protection for computer data information to ensure that it will not be lost or stolen or damaged due to negligence or accidental reasons. A data file is a file that stores data information on a computer, and there are many types of data files, including XML, DAT, which are the two most common types of data files. DAT data file format is a more general file format and can be opened or used by any application, so it is the most widely used. XML data file format is often used for code extensions by programmers and can therefore be called Extensible Markup Language. XML data file format is mainly used to store programming languages in the form of JAVA, C, C++, etc. It is similar to HTML, but XML files are used to store and transfer data and structures over the Internet.

Also, in the era of "Internet+," information security and data security are getting more and more attention. Data file security can be expressed in two ways: firstly, it refers to the security of the data and the data file itself; secondly, it refers to the protection of the data and the

data file. In today's data, file security does not have a precise definition but generally refers to the security of data files on the computer and the risk of data leakage and data packet loss due to threats to data files in the process of transmission.

Essentially, a data file is a file that can store any data information, generally using a binary file format. Moreover, data files should be system files created by computer operating systems or application data files created by applications, or human-created data files, including types such as project files, libraries, or documents. However, due to the development of science and technology nowadays, information security is also threatened by people with wrong intentions, and people are more and more concerned about the security of data information. In order to protect the security of data files, many scholars have presented their insights and analysis. For example, Kun Wang and Yanjun Lu proposed to put data file security control technology, which is researched and implemented mainly by imposing filters on the creation, use, and editing of documents through file filtering-driven technology and protecting the contents of important documents by using transparent encryption and decryption technology. Through the study of various data file control technologies, we provide users with technical support and an overall data file security strategy [1].

2. Security Risks of Data Files

2.1. Data File Security Issues. With the advent of the era of big data, technological advances, the complexity of today's Internet environment, and various types of data processing activities, this paper will analyze the security of data files and risky causes based on the scientific analysis of the threats and security issues facing people's computer data files at this stage, and on this basis, put forward targeted data file security governance strategies for the traditional data file security. The advantages and disadvantages of traditional data file security technologies such as protection management and transmission risks are analyzed. Among them, the security of data files is mainly caused by the following factors (Figure 1).

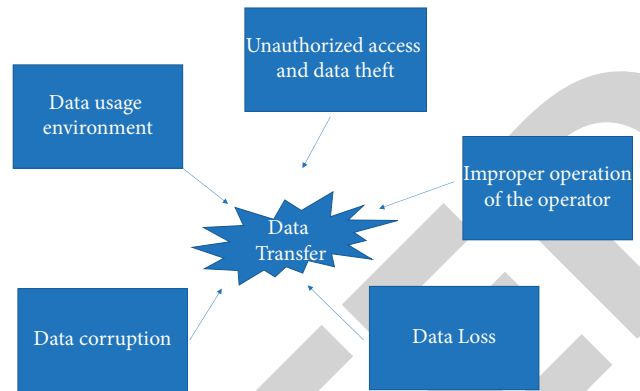


FIGURE 1: Risk factors of data security.

2.1.1. Data File Usage Environment. First of all, the security of data files is analyzed in terms of the environment in which they are used. The environment of data files is mainly composed of the production environment, development and testing environment, office environment, and Internet environment [1]. When people in different environments use the same data file, the data file needs to be transferred and shared for processing, and data security risks will inevitably arise when the data file is circulated in different environments. In the production environment, it refers to the general running production system, business application system with high concurrent access links, and the data file contains a large amount of sensitive information, and the main data security risks are the lack of active interception of batch export and the lack of audit records [2]. In the development and testing environment, the completion of a system or a software and hardware development requires different developers for data development, and the data for development and testing are generally innovative and authentic data, and all the testers involved in the development can access the development data files, making the threat of data security greatly increased [3]. In the office environment, the main data security threats are the lack of active interception of batch export behavior and the inability to supervise operation and maintenance operations. As most of the data in the office environment are financial data, customer information data, production plan data, and business report data, illegal elements will do anything to get these data, making the risk of data file security in the office environment much higher [4]. In the Internet environment, due to a large number of branches of large enterprises, the need to share data transmission makes illegal elements frequently attack the transmission path of their data files or directly intercept the network during transmission in order to threaten such companies or to obtain important secrets of such companies and sell them to others for profit. Therefore, in the Internet environment, the threat to data security cannot be ignored, and the slightest mistake may cause irreparable damage to a company or group of companies.

2.1.2. Unauthorized Access and Data Theft. In addition to the threat to data file security posed by the data usage environment, unauthorized access is also an important threat

factor that cannot be ignored. Unauthorized access refers to the bad behavior of copying, pasting, modifying, or destroying data files of computers without the consent of computer users [2]. In the era of big data today, the value of data has attracted people's attention, and most people think that data is private and has its value and significance, especially for scientific research results, but there are some unscrupulous people who have evil intentions to get the computer data files, thus using some technical means to cross the administrator's management authority to delete, modify, copy, and do other operations on other people's computer data files [5]. In order to get the computer data files, some unscrupulous people use some technical means to transgress the administrator's management rights and delete, modify, copy, and do other operations on other people's computer data files, thus causing the leakage of data and theft of scientific research results [6]. Unauthorized access generally has the following forms: the first is to impersonate administrators or users, invade other people's computers, obtain access rights, and use illegal means to plagiarize other people's data files; the second is to control and enter other people's computers through network attacks, copy, delete, and modify scientific research results or directly delete important system data files inside computers. The second is to control and access other people's computers through network attacks, to copy, delete, modify scientific research results, or directly delete important system data files inside the computer, resulting in the leakage or theft of data files, as well as direct virus invasion of the computer, resulting in the computer no longer being used, and naturally, the data files inside the computer cannot be accessed and modified, copied, etc.

2.1.3. Data Corruption. Data corruption refers to the subjective and malicious damage to the data itself, resulting in the unavailability of computer data files or the loss of important files, which affects the use of the computer. There are many reasons for data corruption, the most important of which is the damage caused by virus infection to data files, followed by "hacking" programs or software bundles, software bugs, and other reasons to cause damage to data files [7]. Some computer viruses are usually hidden,

sometimes even through the security manager, and other antivirus software cannot be detected. This kind of hidden computer viruses, after the invasion of the computer, can get all the rights to use the computer, can manipulate the computer's data files at will, delete, copy, or modify at will.

2.1.4. Data Loss. For individuals, the loss of data can cause many adverse consequences, such as the risk of privacy exposure if the data files are lost; secondly, if the data files related to personal preferences are lost or "targeted" by businesses, it can greatly affect the quality of life of individuals, such as businesses to promote their products or software to promote a certain product, always pushing some promotional information or phone calls, SMS bombing, seriously affecting life. For enterprises, the loss of critical data will be incalculable. Relevant studies show that global enterprises lose \$1.7 trillion due to downtime or loss of critical data files. This is only the monetary loss; there is also the loss of hidden assets, such as business processing, business activity interruption, loss of customer loyalty, funds for reallocation of resources, production suffers stagnation and investor confidence, etc., which will have a long-term impact on the company [8].

2.1.5. Operator Misconduct. Firstly, when using important data files with passwords, due to the handover of data files to multiple parties, it may cause the error of improper use of passwords, which may lead to the phenomenon of data files being locked after repeatedly entering wrong passwords; secondly, some staff members are not familiar enough with computers, improperly using antivirus software or directly and unintentionally The firewall is closed, and the computer with insufficient protection is unable to prevent the invasion of viruses, thus contaminating the data files of the computer; thirdly, the intranet uses computers for illegal outreach. Some scientific research institutions or enterprises with strong confidentiality may require the use of an intranet to test and develop data files, but if the operator does not operate properly and mistakenly uses the external network, it will lead to the risk of leakage of key data files; finally, the use of bad email or data sharing by external operators does not use the regular way, resulting in important confidential data files being attacked and intercepted in the process of data transmission, increasing the leakage of data files [9]. The risk of data file leakage is increased by the use of bad emails or the failure of the operator to use formal channels for data sharing.

In summary, most of these five types of security issues regarding data files are related to data transmission and data sharing. The security of data files during transmission and download is also related to the packet loss rate, which may cause data leakage. The data loss rate is related to whether the data buffer is overflowing or not. Therefore, in this paper, we consider the use of a fuzzy control algorithm to set the cache and propose a strategy and analysis for the security of data files.

2.2. Data File Transfer Techniques and Problems

2.2.1. Data File Transmission Methods. In today's era of information explosion, it is more and more common to send and receive data files over 1 GB in size, such as images taken by photographers using DSLR cameras can reach several tens of MB, but the memory occupied by the video is almost 1 GB in size. For multinational companies, the transfer of data files with large data volumes has become a daily requirement, and now that data has become an important production resource, the improvement and enhancement of transmission methods and distribution technologies for massive data have become a goal to be pursued [10].

So, how are large files transferred in daily life? What are the common transmission technologies?

First of all, HTTP, i.e., Hypertext Transfer, is a classic distribution transfer method that mainly uses the bandwidth and storage of the server to transfer and distribute files, but the HTTP link between the client and the server is a one-time connection, i.e., the connection will be closed automatically each time the server returns an answer to a request [11].

As shown in Figure 2, the HTTP-based file transfer mode has four main steps: first, the client establishes a connection with the server; second, the client makes a request to the server for data file transfer after the connection is established; third, the server responds with an answer and returns the data file; then the server and client automatically close the connection, completing the entire process of the data file transfer.

Next is FTP mode, that is, File Transfer Protocol, abbreviated as "File Protocol," mainly used for two-way transmission on the Internet, is a file distribution method similar to HTTP [12]. FTP is an application layer protocol based on C/S architecture, and the underlying application is TCP/IP protocol to ensure the reliability of transmission. The block diagram of FTP mode in the process of data file transfer is shown in Figure 3.

As can be seen from Figure 3, FTP makes it possible to share data files between service hosts and between servers and clients, which is essentially copying files back and forth between two hosts [13]. The basic process of FTP is firstly, establishing a connection, secondly, transferring data and releasing data, and finally, releasing the connection [14]. Observing Figure 3, we can see that there are two types of connections in FTP mode, namely data connection and control connection, so there are two ports between FTP server and client, one for transferring commands and one for transferring data. This design method is mainly to solve the problem that the FTP server has less control information but a large amount of data.

Finally, there is the data file transfer method for software classes such as QQ, mail, and Baidu.com. With a large number of QQ users, the main function of QQ is to exchange and communicate, so QQ is only suitable for transferring data files less than 1 GB. If it exceeds 1 GB, then the transfer rate will become particularly slow; even though QQ now supports data file transfer in offline mode, it is always easy to

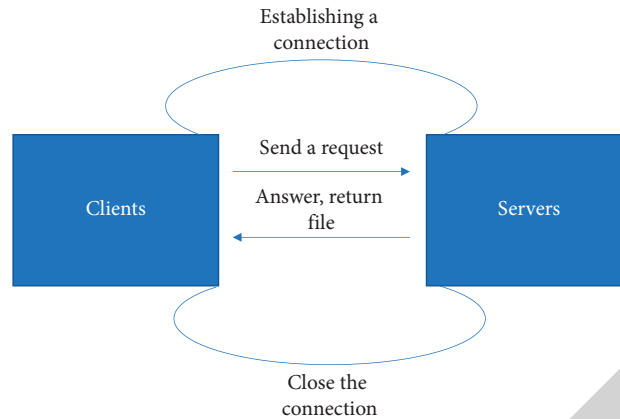


FIGURE 2: Typical HTTP transaction processing principle of operation.

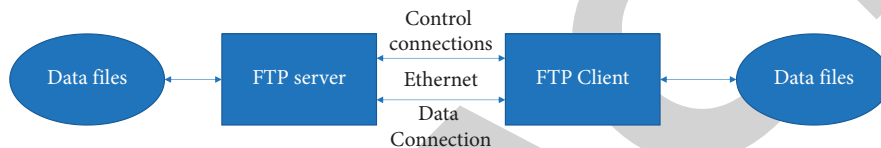


FIGURE 3: Block diagram of FTP mode working principle.

cause data transfer interruption and other phenomena when transferring large files for various reasons [15]. For emails, it is also a common way to transfer data files, but it takes the form of attachments for transferring, and the size of the attachments is generally 10–30 MB. If the emails are transferred with larger attachments, the successful transfer of the emails may not be guaranteed due to the other party's server and network stability, and if the other party does not receive the files in time, the files will expire. This is because the file transfer station of emails has a certain time limit. For this kind of software, the main function of Baidu.com is cloud storage, which can also meet the needs of people in daily life, such as document management, photo storage, and data file transfer. It is because the main function of Baidu.com is to store data, so it has a large storage space and supports file classification and browsing and multiplatform data sharing, but its shortcomings are also obvious, such as downloading and uploading data files at a limited speed, only a few dozen k a second if not open super members, which is difficult to meet people's requirements for timely and lightweight data file transfer [16].

2.2.2. Analysis of Advantages and Disadvantages of HTTP and FTP Transmission. In the previous subsection, three data file transfer methods were discussed, and since the software class belongs to the data file transfer method on the application, this paper does not explore them [17]. But what are the advantages and disadvantages of HTTP and FTP data file transfer methods?

First is the HTTP mode. HTTP mode is mainly a protocol way to transfer data through direct networking. There are four common methods of the HTTP protocol,

namely GET method, POST method, PUT method, and DELETE method. The GET method is designed to obtain a resource on the server and is one of the earliest methods proposed by most HTTP protocols. GET method, after requesting data information attached to the server's interface, will start with "?" splitting the URL and the transmitted data, for multiple parameters will use "&" connection, but the amount of data transmitted by this method is limited by the length of the URL and is only suitable for small amounts of data transmission [18]. However, for the POST method, in theory, the size of the transmitted data realized by this method is not limited; for the PUT method, it is generally used to modify the URL resource. If the URL resource does not exist, the server will request the corresponding URL resource according to the request. If the resource exists, it will request to modify the original URL [6] resource. The DELETE method corresponds to the English "delete," which means requesting the server to delete a specific resource [19].

The reliability of data file transfer based on HTTP protocol is high because HTTP protocol is based on TCP protocol for data transfer. However, because HTTP protocol is a plaintext transmission protocol, there is no encryption in the process of data file interaction, so the security of HTTP protocol is poor. Its plaintext transmission protocol makes data files in the transmission process with a risk of data file exposure and leakage.

Next is the FTP protocol [20]. FTP has no limitation on file size and is relatively simple to operate. However, when the volume of data files is large, the speed will become slower and the problem of data transmission interruption will easily occur, resulting in data transmission errors. Moreover, the FTP server also transmits data in clear text, which poses a threat to security. In addition, FTP also lacks sufficient

control functions, such as the lack of audit function, there is no way to judge and guarantee the compliance of the sent data, and the flow of data is also uncontrollable, which may cause the risk of data leakage for the transmission of data files [21]. What's more, the use of an FTP server may lead to problems such as poor traceability of data files. This is due to the characteristics of FTP, which is limited in its ability to trace file transfers.

As we can see from the above discussion, both HTTP protocol and FTP server exchange data in clear text form for data file transfer, using the "request + response" model. Most of websites nowadays use the less secure HTTP protocol, which may cause packet loss due to the difference in the acceptance rate of both computers' file systems when the data file transfer is too large. For this problem of FTP server, it is necessary to set cache area between the client and server of data file transfer to automatically deal with the problem of packet loss when data files interact or the failure of saving due to unknown data lines, etc. Based on this, a data file security strategy based on a fuzzy control algorithm is proposed and analyzed, and implemented through experiments [22].

3. Fuzzy Control Algorithm

As we can see from chapters 1 and 2, the security risk of data files is not only related to internal factors but also to external factors, and data file sharing is inevitable regardless of internal and external factors. Since there is a demand for data file sharing, data files are bound to be transferred [23]. In the process of data transfer, both HTTP protocol and FTP protocol used have certain security problems. This paper mainly focuses on the data file sharing and transmission process by proposing the use of a fuzzy control algorithm to increase the cache in the process of data file transfer in order to reduce the packet loss of data files, and at the same time, in order to increase the security and improve the reliability of data files. After that, a data file transmission model is constructed so as to realize the security policy scheme for data files, and a data file security model based on a fuzzy control algorithm is constructed, which has a certain reference value for subsequent research [24].

Next, the theoretical part of the fuzzy control algorithm is described in terms of an overview of fuzzy control theory, input and output variables of fuzzy controller, the establishment of fuzzy rules, and fuzzy relations and fuzzy reasoning. One of the general block diagrams of the fuzzy control algorithm is shown in Figure 4 [25].

3.1. Overview of Fuzzy Control Theory. In 1965, L.A. Zadeh proposed the fuzzy set theory, which has been widely used and developed since then; in 1973, in order to make the fuzzy set theory more perfect, he also proposed the use of fuzzy linguistic variables to represent the control state of the relevant control variables and achieve effective control of the variables through fuzzy linguistic variables, and in the same year, he also formally proposed the definition of fuzzy control and The theory related to fuzzy control [26].

Fuzzy control algorithm, a control strategy method that uses language to generalize the operator, is an intelligent control method based on fuzzy set theory, herding linguistic variables, and fuzzy logic reasoning. The method is based on a priori knowledge, incorporating human experience in a traditional nonlinear system and fuzzifying the obtained rules to compile a set of rule base's and complete fuzzy inference, followed by fuzzy verdict and finally defuzzification of the signal or data after the verdict is completed using a defuzzifier. This is the basic process of the whole fuzzy control algorithm [27].

In the fuzzy control algorithm, the most important feature is that there is no need to establish a precise mathematical model of the controlled object but only to require experts or related technical personnel to use professional knowledge or a priori knowledge to summarize experience and data into more perfect linguistic control rules; therefore, in essence, fuzzy control can also be considered as a kind of expert control, which can fully reflect the activities of human thinking and the process of thought. The core of the fuzzy control algorithm is the fuzzy controller [28].

3.2. Input and Output Variables of the Fuzzy Controller.

As can be seen from Figure 4, the fuzzy controller needs to be generated before it can be used. Generating fuzzy is actually the input variable of the fuzzy controller, and removing fuzzy is the output variable of the fuzzy controller. During the control of the controlled object, three variables are generally used for decision making: the deviation between the set value and the controlled quantity, the deviation change EC, and the rate of deviation change.

In fuzzy control, both input and output variables are described in linguistic form, so an appropriate language is selected for the description. This collection of linguistic forms describing the fuzzy can be called a fuzzy set. A prerequisite for a fuzzy controller's input to be used as output is its fuzzification, which is essentially the conversion of an exact input quantity into a corresponding fuzzy [10] vector.

In the fuzzy quantity of a variable, the actual range of variation of a variable becomes the fundamental domain [29]. Obviously, the range of variation in the fundamental domain is the real exact value of the variable, which is required in the fuzzy controller, so the exact quantity needs to be fuzzified. Let the basic theoretical domain of deviation be $(-X, X)$, the basic theoretical domain of deviation change be $(-XC, XC)$, the basic theoretical domain of output variable of fuzzy controller be $(-Y, Y)$, the conversion formula from the basic theoretical domain $[a, b]$ to fuzzy subset theoretical domain is as follows:

$$y = \frac{2n}{b-a} \left[x - \frac{a+b}{2} \right]. \quad (1)$$

In the vocabulary for describing input and output variables, three levels of words are generally used, such as "fast, medium, slow" for describing speed; however, in practical applications, three words "large, medium, small" are

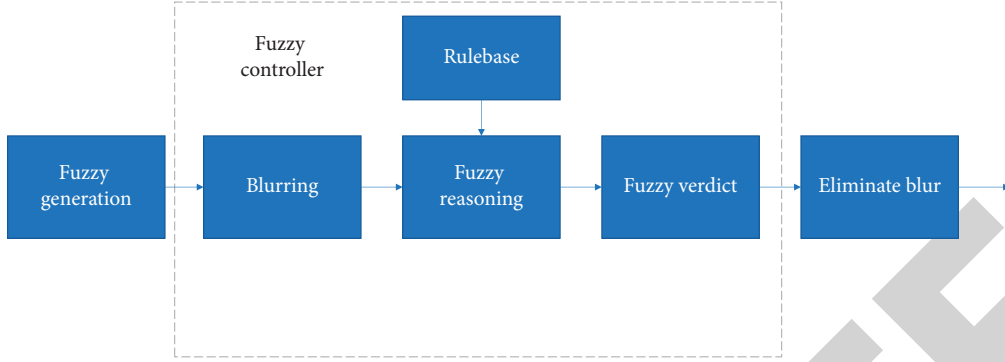


FIGURE 4: Basic block diagram of fuzzy control system.

generally chosen to describe the input and output variables of a fuzzy controller [30]. However, in practical application, we generally choose to use “large, medium, and small” to describe the input and output variable states of the fuzzy

controller, plus positive, negative, and zero states, which can be expressed in English and Chinese as shown in the following equations:

$$E = \left\{ \begin{array}{l} \text{negative large, negative medium, negative small,} \\ \text{zero, positive small, positive medium, positive large} \end{array} \right\} \quad (2)$$

$$= \text{NB} \cdot \text{NM} \cdot \text{NS} \cdot \text{ZEPSPMPM},$$

$$E = \left\{ \begin{array}{l} \text{negative large, negative medium, negative small, positive zero,} \\ \text{negative zero, positive small, positive medium, positive large} \end{array} \right\} \quad (3)$$

$$= \text{NB} \cdot \text{NM} \cdot \text{NS} \cdot \text{NO} \cdot \text{PO} \cdot \text{PS} \cdot \text{PM} \cdot \text{PB}.$$

The terms described in the above equations are not necessarily chosen in full, but can also be chosen less; e.g., the range of error variables expressed in equation (2) is one state less than that of equation (3).

3.3. Affiliation Function and Fuzzification. As can be seen from Figure 4, the knowledge base is the whole part framed by dashed lines, including two parts, the database and the rule base. The rule base is another linguistic representation of fuzzy reasoning, which is the a priori knowledge derived from the long-term work of experts or other professionals; the database is a collection composed of affiliation vectors. Among them, the affiliation is to achieve fuzzification, i.e., to establish a relationship between the exact quantities discretized in Section 3.2 and the fuzzy quantities representing the fuzzy language, describing the degree to which a variable belongs to the language of a fuzzy variable, which is called the affiliation function in the case of a continuous domain of the argument.

The affiliation function, which is mainly designed to reflect the fuzzy character of the fuzzy set, plays a key role in the overall fuzzy [11] controller. When fuzzy control is performed on variables, the first step is to fuzzify them, mainly by applying the affiliation function to the input variables to make the input variables themselves more accurate, but the processed input variables are converted to

fuzzy vectors. Therefore, when constructing a fuzzy set, the affiliation function should be selected appropriately so that the variables can be fuzzified reasonably.

3.4. Fuzzy Relations and Fuzzy Inference. Fuzzy relationship is a relatively common relationship in nature, except that some fuzzy relationships are difficult to be detected. The fuzzy relationships that exist between things can be described by the degree of association formed by fuzzy theory. This degree of association is usually expressed in the form of a matrix.

In fuzzy reasoning, it refers to the process of formulating fuzzy rules for the input variables of a fuzzy control system, combined with the social experience or a priori knowledge of experts or professionals, from which a fuzzy relational equation can be formed, and the final fuzzy control output is obtained. In computer language, it is similar to forming a kind of if-else statement, i.e., if the expression in parentheses is true, the statement is executed; if it is false, the content in the else statement is executed. The key in fuzzy reasoning is to use the relation matrix obtained under fuzzy relations and perform mathematical operations on it so that the fuzzy set can be processed effectively to finally output the output variables of the fuzzy controller.

Before the process of fuzzy inference, it is necessary to first construct fuzzy sets and establish a meaningful and

complete rule base in the form of affiliation functions of fuzzy sets or other linguistic descriptions of the input variables that can drive the application of fuzzy inference.

3.5. Defuzzification. Defuzzification is the final step of a fuzzy controller, which means that the fuzzy values obtained from the previous fuzzy inference are converted to exact values and used as inputs to another control system. There are two commonly used methods in defuzzification, which are the maximum affiliation method and the weighted average judgment method.

4. Fuzzy Control Based Data File Security Policy Scheme

4.1. Basic Implementation of ftp Server. There are two ways to connect FTP. One is the connection of control command, i.e., the connection between client and server; one is the connection of data transfer, and the FTP service program generally supports two different working modes, which are passive (passive) mode and active (port) mode. The connections in both of these modes are shown Figures 5 and 6.

In active mode, FTP runs on ports 20 and 21, where port 20 is mainly used for data flow transfer between the client and the server, and port 21 is mainly used for transferring commands for interaction between the client and the server. In active mode, the client firstly requests a control connection to port 21 of the server, secondly sends port commands to the server through port 21 on the connection, and finally, the FTP server transfers data files through the data connection port indicated by the port command. Since port mode has specified that port 20 and port 21 must be used, to establish the development of FTP server data file transfer, the passive mode must be used, which works as shown in Figure 6.

In the passive mode, the biggest difference from the active mode is that its server control port is 21, but the data port is a random port larger than 1024. Therefore, in the passive mode, the data port of the client has to actively connect to the data port of the server, whose data port is random.

4.2. General Framework of Data File Security Policy under Fuzzy Control. First of all, the analysis of data security problems shows that most data files have the risk of data leakage problems related to the transmission or sharing of data files, so this paper mainly focuses on the data security problem when data files are transmitted and shared under the study of data file security policy. Based on the analysis and discussion in the previous section, data files are generally transmitted using software-based and protocol-based methods. Since there is no specific research significance for software-based data file transmission, this paper focuses on a new model for the secure transmission of protocol-based data files.

The first 3 sections analyze the advantages and disadvantages of HTTP and FTP and get the conclusion that both of them use plaintext transmission and have problems such

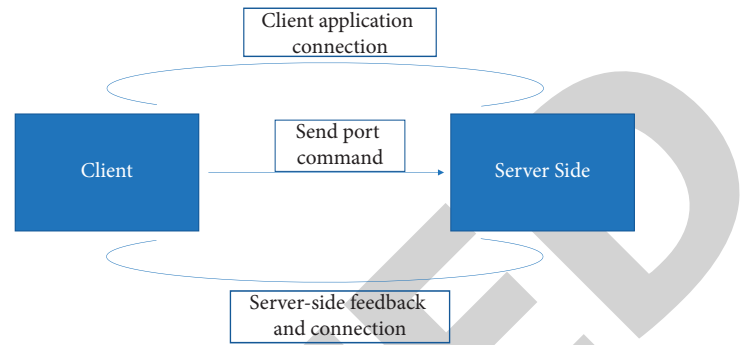


FIGURE 5: Control connection and data connection in port mode.

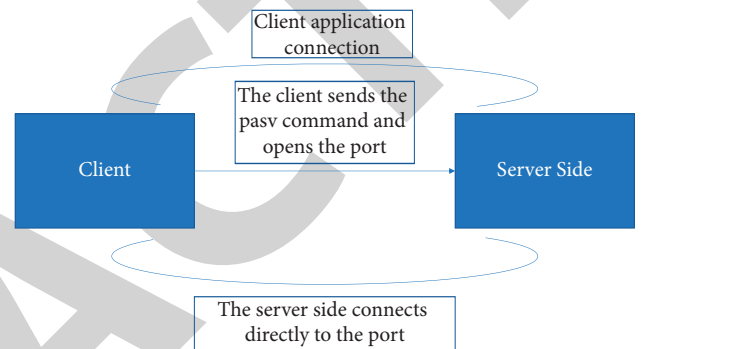


FIGURE 6: Control connection and data connection in passive mode.

as poor security and confidentiality. Since HTTP protocol is mostly a data file transfer on a browser, and an FTP server is essentially a “copy” of data files between two computers, this paper studies the construction of a security policy for data file transfer using an FTP server.

However, if the FTP server is used only for simple command operation of data files, it does not solve the problem of security and reliability of data files, and it is known from Section 3 that the path of data file transmission can be controlled by using fuzzy control algorithm to achieve the effect of “encryption.” Based on this, this paper proposes a data file security policy model using a fuzzy control algorithm, and its model block diagram is as follows (Figures 7, 8).

For Figure 7, traditional pasv mode, because the server will open a port for the client to connect, but if the opening of this port does not detect which client’s IP is connected, then the security of the data file is naturally threatened and affected when the interaction is carried out. Also, since many FTP servers open data connections randomly, if the FTP server does not determine whether the port requested by the client is a legitimate login when receiving data, other illegal users may attack it in order to get some critical data files [12]. In addition, the FTP server can also generate buffer overflow when interacting with data files on the client side, which can cause data file loss problems. In order to prevent such problems, this paper introduces a fuzzy control algorithm to set cache when the FTP server and client interact with each other to reduce data file loss.

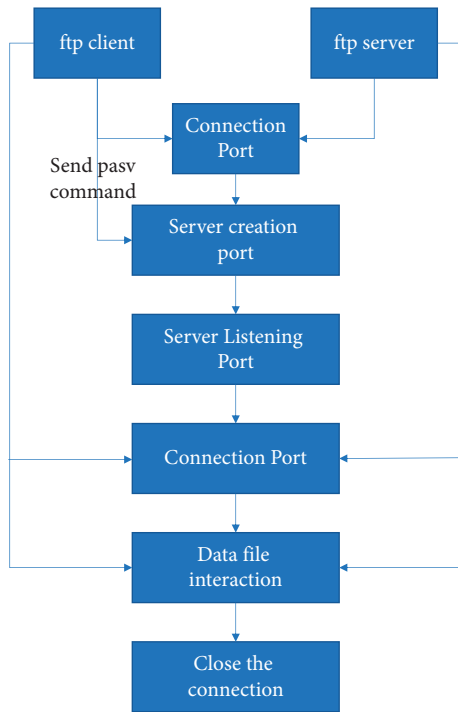


FIGURE 7: The working process of data file interaction by ftp under traditional passive mode.

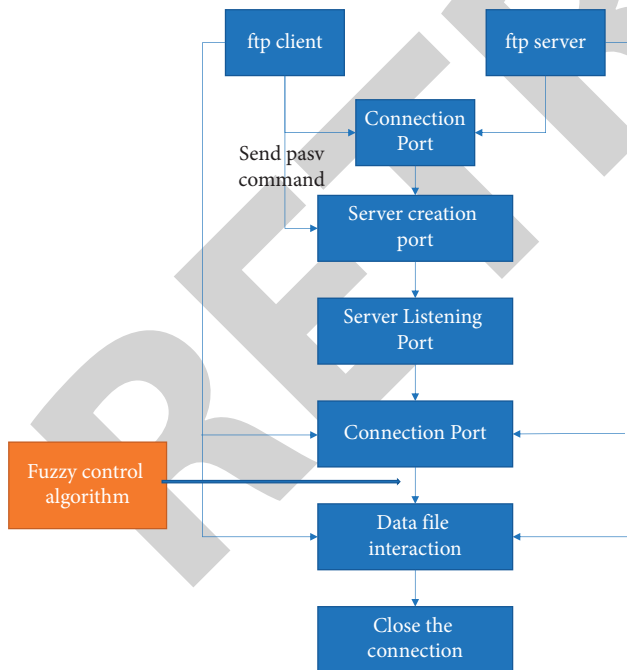


FIGURE 8: The model of data file security interaction based on fuzzy control algorithm constructed in this paper.

4.3. Experiment on Secure Data File Interaction under Fuzzy Control. After the above analysis, in order to test whether the new strategy proposed in this paper can guarantee the security of data files and because the data cache conflict

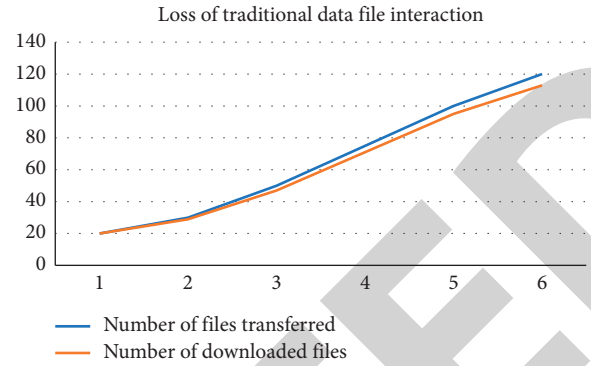


FIGURE 9: Loss of the number of transferred files and downloaded files for traditional FTP server data interaction.

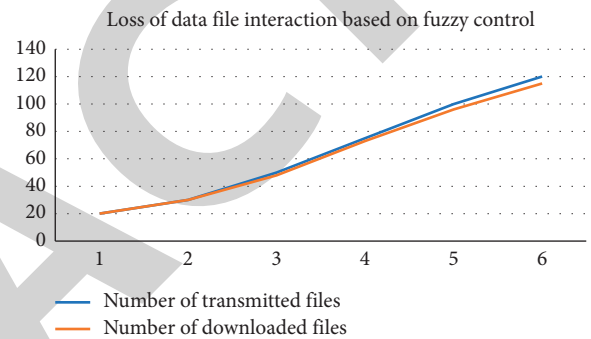


FIGURE 10: Loss of the number of files transferred and downloaded during FTP server data file interaction based on fuzzy control.

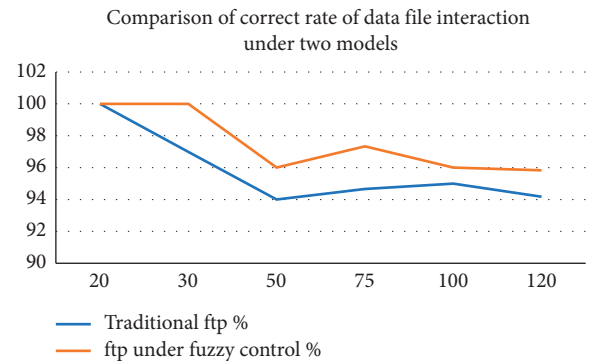


FIGURE 11: Comparison of the correct rate of data file interaction under two models.

phenomenon has randomness. In order to test whether the [13]new strategy proposed in this paper can guarantee the security of data files and because the data cache conflict phenomenon has the characteristics of randomness and instability, this paper will measure the loss of data file transfer and download and the efficiency of transfer and download under windows + VMware Workstation virtual CentOS6.5 operating system for the data file transfer interaction between traditional FTP server and FTP server based on a fuzzy algorithm, and finally, the experimental results are shown in Figures 9-11.

Comparing Figures 9 and 10, it can be seen that the average loss rate of data files under the traditional FTP server model is about 4%, while after adding the fuzzy control algorithm to intervene in the data file interaction, the average loss rate is reduced to about 2.5%, and the data file interaction under the new model is about 1.5% lower than the traditional loss rate; then observe Figure 11. The comparison of the correct rate under the data file interaction model shows that the correct rate of the traditional FTP server number file decreases to more jittery with the increase of data volume, and its accuracy rate is also lower than that of the data file interaction model under the fuzzy control algorithm based on the fuzzy control algorithm.

5. Conclusion

In this paper, through the analysis of the security risk of data files, it is found that the security problems of data files are essentially related to the interaction and sharing of data files, while data files have data file loss and data buffer overflow caused by data file security problems when passing HTTP or FTP. After a detailed analysis of the advantages and disadvantages of HTTP and FTP, through the reading of related literature, it is found that the fuzzy control algorithm can change the transmission path of data files and make appropriate corrections for incorrect file transmission paths through fuzzy rules, thus improving the accuracy of data files during data transmission and download interactions.

Data Availability

The labeled dataset used to support the findings of this study is available from the corresponding author upon request.

Conflicts of Interest

The author declares no conflicts of interest.

References

- [1] S. Jitendra Kumar and A. Tiwari, "Network intrusion detection using ACO-DNN model with DVFS based energy optimization in cloud framework," *Sustainable Computing: Informatics and Systems*, vol. 35, 2022.
- [2] L. Yan, C. Xia, and C. Yin, "A consensus-based privacy-preserving energy management strategy for microgrids with event-triggered scheme," *International Journal of Electrical Power & Energy Systems*, vol. 141, 2022.
- [3] Halder Subir and N. Thomas, "Enabling secure time-series data sharing via homomorphic encryption in cloud-assisted IIoT," *Future Generation Computer Systems*, vol. 133, 2022.
- [4] J. A. Kleboth, H. Kosorus, and at al. Rechberger, "Using data mining as a tool for anomaly detection in food safety audit data," *Food Control*, vol. 138, 2022.
- [5] A. Abdelrahman and K. Mohsen, "Mitigation of False Data Injection Attacks on Automatic Generation Control Considering nonlinearities," *Electric Power Systems Research*, vol. 209, 2022.
- [6] H. Wang and Li Yuan, "Susilo at al. A fast and flexible attribute-based searchable encryption scheme supporting multi-search mechanism in cloud computing," *Computer Standards & Interfaces*, vol. 82, 2022.
- [7] C. Singh, "Edward Jaya, Sunitha at al. Chaotic and Paillier secure image data sharing based on blockchain and cloud security," *Expert Systems with Applications*, vol. 198, 2022.
- [8] V. Madhav Kuthadi, R. Selvaraj, S. Baskar, and P. Mohamed Shakeel, "Data security tolerance and portable based energy-efficient framework in sensor networks for smart grid environments," *Sustainable Energy Technologies and Assessments*, vol. 52, Article ID 102184, 2022.
- [9] S. Fal, T. van Deursen, and K. Sandeep, "A ZigBee intrusion detection system for IoT using secure and efficient data collection," *Internet of Things*, vol. 12, 2020.
- [10] X. Xiong, S. Hu, D. Sun, S. Hao, H. Li, and G. Lin, "Detection of false data injection attack in power information physical system based on SVM-GAB algorithm," *Energy Reports*, vol. 8, no. S5, pp. 1156–1164, 2022.
- [11] S. Acharya and M. Mekker, "Importance of the reputation of data manager in the acceptance of connected vehicles," *Communications in Transportation Research*, vol. 2, Article ID 100053, 2022.
- [12] Yu-li Liu, L. Huang, W. Yan, X. Wang, and R. Zhang, "Privacy in AI and the IoT: the privacy concerns of smart speaker users and the personal information protection law in China," *Telecommunications Policy*, vol. 46, no. 7, Article ID 102334, 2022.
- [13] Y. A. Woldie, "The Ethiopian Energy Sector and its Implications for the SDGs and modeling," *Renewable and Sustainable Energy Transition*, vol. 2, 2022.
- [14] D. Singh and B. Singh, "Secure chess-based data exchange and user validation," *Journal of Cases on Information Technology*, vol. 24, no. 4, pp. 1–10, 2022.
- [15] A. V. L. N. Sujith, G. S. Sajja, V. Mahalakshmi, S. Nuhmani, and B. Prasanalakshmi, "Systematic review of smart health monitoring using deep learning and Artificial intelligence," *Neuroscience Informatics*, vol. 2, no. 3, Article ID 100028, 2022.
- [16] Di Wang, Y. Lv, and Chen, "The spatial data sharing security model based on hybrid encryption algorithm," Article ID 11884, 2021.
- [17] Z. Krzysztof and S. Ksenia, "Car Safety Support System on the Base of Data Mining Algorithm," in *Proceedings of the Second Conference on Sustainable Development: Industrial Future of Territories (IFT 2021)*, p. 195, Beijing, China, October 2021.
- [18] S. Kumaresan and V. Shanmugam, "Time-variant attribute-based multitype encryption algorithm for improved cloud data security using user profile," *The Journal of Supercomputing*, vol. 76, no. 8, pp. 6094–6112, 2020.
- [19] K. Tamilarasi, A. Jawahar, "Medical data security for healthcare applications using hybrid lightweight encryption and swarm optimization algorithm," *Wireless Personal Communications*, vol. 114, 2020.
- [20] W. Hu, J. Li, J. Cheng, H. Guo, and H. Xie, "Security monitoring of heterogeneous networks for big data based on distributed association algorithm," *Computer Communications*, vol. 152, no. C, pp. 206–214, 2020.
- [21] A. F. Doni, S. Hanif, O. A. H. Maria, and S. Hanif, "Implementation of RC4 cryptography algorithm for data file security," *Journal of Physics: Conference Series*, vol. 1569, no. 2, Article ID 022080, 2020.
- [22] H. Omrani, M. Amini, and A. Alizadeh, "An integrated group best-worst method – data envelopment analysis approach for evaluating road safety: a case of Iran," *Measurement*, vol. 152, Article ID 107330, 2020.

Retraction

Retracted: Construction of Multimedia English Teaching Resource Base Based on *K*-Means Clustering Algorithm

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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] J. Yan, L. Wu, and Q. Wang, "Construction of Multimedia English Teaching Resource Base Based on *K*-Means Clustering Algorithm," *Security and Communication Networks*, vol. 2022, Article ID 4397617, 12 pages, 2022.

Research Article

Construction of Multimedia English Teaching Resource Base Based on K-Means Clustering Algorithm

Jinyan Yan ¹, Lianfang Wu,¹ and Qinghong Wang²

¹Basic Teaching Department, Aba Vocational College, Maoxian, Sichuan 623200, China

²Economic Management Department, Aba Vocational College, Maoxian, Sichuan 623200, China

Correspondence should be addressed to Jinyan Yan; 18990432506@163.com

Received 27 May 2022; Revised 27 June 2022; Accepted 12 July 2022; Published 26 August 2022

Academic Editor: Tao Cui

Copyright © 2022 Jinyan Yan et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Because of the explosive development of the Internet today, network education resources are becoming more and more valuable, and so is the rapid development of the information teaching environment. Let us pay more attention to the construction of teaching resources. In order to help schools improve the quality of teaching and promote the reform of basic education in China, the teaching resource bank must be enriched in connotation and perfect in function. However, the current teaching database is still facing some difficulties in the construction process, such as insufficient information, and database content structure relative disorder. In fact, the progress of computer technology is likely to help overcome the above difficulties, but there are still some problems in the construction process of the current teaching resource database, such as the connotation of teaching resources is not full, the organization structure of the content of the education resource database is relatively messy. The development of computer technology is likely to help solve the above problems. Therefore, the research on constructing the service system using computer technology has become a very key and hot topic today. Based on the current situation of resource library construction and the classification and summary of some technical problems, the author of this study puts forward a set of methods and procedures for the construction of a multimedia English teaching resource library. An improved hybrid clustering algorithm ISPO + K-means was proposed to integrate PSO and K-means. Compared with other algorithms, the algorithm clustering results are better. Based on this process, this study can automatically sort and classify the collected learning resources, reduce the consumption of manpower and material resources, and improve the service efficiency of the resource library. The purpose of this study is to find the methods that can use information technology to serve the construction of a multimedia English teaching resource bank, hoping to provide a valuable reference for the related research on the construction of teaching resource bank.

1. The Introduction

With the in-depth development of the Internet information technology era, social education has officially entered a new era of highly informationized network education. Through the connection of mobile Internet, teaching and resources have gone beyond the previous time and space scope, and the range of access to knowledge information materials has rapidly expanded from the existing classroom, laboratory, and school library to other places covered by the Internet. However, the network is only one of the information carriers in the dissemination of knowledge and information resources. How to efficiently absorb and share learning information resources is still the concern of the vast majority

of network users. Rich resources effective multimedia network and education technology will be independently personalized to guide students to the active learning process of cooperative learning and creative key, is also help teachers create interactive classroom interactive teaching, orientation training, and other interactive educational activities necessary foundation support and guarantee conditions for success [1]. In the field of educational theory and information computer science, many experts and scholars at home and abroad have invested a lot of energy, time and money, and material resources to study and discuss various new network education information technology schemes, education information platform construction and advanced application of interactive virtual learning technology to

create a new interactive teaching environment. However, it is worth noting that no matter how valuable the program, platform resources, and environment are, their value cannot be separated from the support of quality educational resources [2]. It can be seen that the government should pay more attention to the construction of high-quality resources for public education. Therefore, how to efficiently collect and manage information and optimize the campus information resource database has gradually become an increasingly important practical subject for schools, especially to explore how to make the school information technology directly serve the optimization construction of campus education resource database, which has been a long-term prominent issue of concern in the field of university education and technology [3].

At present, the rapid development of information technology innovation involves a variety of information resource data automatic collection, sorting and classification, and rapid retrieval, including automatic network information crawler, automatic classification, information batch extraction, automatic query questions, data mining, natural language analysis, and processing functions. At the same time, there are all kinds of intelligent data collection and automatic retrieval of relevant information data system tools, such as intelligent web crawler system tools and various general intelligent search engines, such as Google, Yahoo, Baidu search engine, and other application systems, are specially equipped with their specific needs [4]. However, because the network users in different information fields have many special requirements of different levels, the general database system can not fully meet the diversified query needs of its users. Especially at present, with the gradual enrichment of various types of network data modules and the continuous in-depth development of the next-generation network technology platform technology, a large number of existing network multimedia resources (image, audio, video, etc.) and access to database resources, Single query technology can not effectively and timely obtain and quickly discover semi-structured or even semi-non-fully structured data. All these need to fully combine the existing advanced technology, in order to fully meet the domestic and foreign different aspects of enterprises and industry users of the diversified service needs [5]. Currently, the connectivity between the various technologies needed to collect and classify resources is largely manual. You can see that in this case, it is necessary to establish a set of automatic resource collection and sorting templates for a specific domain of multimedia English education resource databases [6].

2. Research Status

At present, teachers at home and abroad are still gradually committed to the establishment of educational resource databases. Through an extensive collection of high-quality teaching materials, teaching plan information, and other teaching data resources related to teacher training, and further processing and sorting, the basic purpose of fully integrating resources and reasonably sharing the content of

the existing digital teaching database resources is achieved. In this regard, there are three foreign projects: GEM in the United States, Edna in Australia, and Edusource in Canada.

At present, both at home and abroad are devoted to the establishment of educational resource database [7]. Through collecting teachers' teaching materials, teaching plans and teaching resources, and further sorting, to achieve the purpose of integrating and sharing the content of these teaching resources. There are three foreign projects in this regard: GEM in the United States, Edna in Australia, and Edusource in Canada [8].

Gem is an American educational resource database development and application project. One of the main ideas of the initial system design proposed by him was to re-classify the massive educational information integrated by online communities and the rich and diverse resources of global high-quality online education and learning projects through systematic, effective, and rigorous organization and integration design. Further, help school teachers and ordinary young students to choose and use these high-quality network resources safely and efficiently. Its overall design and functions are mature and complete, and the content level is reasonable and rich. It is equipped with a simple and practical search engine system and an interactive online question-and-answer query system. Gem does not require deliberately collecting the most abundant and reliable network information resources, but it is still in essence to build a network information education resource directory system with larger-scale resources. Gemcat, GemHarvest, and Browser Builders are the other three main technology tools used by GEM to develop a platform for building educational resource portals. Using metadata tools from Gemcat standard, users can easily and quickly automatically classify, sort out, query, and describe information data of various education and training resources according to Gemcat standard. It also allows each resource directory creator to automatically generate metadata and control the vocabulary for each resource tree. Metadata is a web page inserted as a meta tag into a resource format. Gemsearch data collection and analysis tool is a featured search engine. Through the adoption of this kind of similar to the robot, the operation mode of the automatic search engines can fast accurate reference to the local contains a large number of gem format metadata resources page, directly from the source web directory can automatically extract relevant resources data, form for the index of local content, and at the same time to realize automatic assembly and add the information to the local portal directory list. The file migration tool effectively and conveniently helps customers to solve a series of technical problems when they do not register address information in the directory file list, or they cannot effectively migrate the registered address directory list and resource file directory.

The second tool, Edna, mainly contains metadata collected through the GemHarvest program to create a simple interactive HTML teaching page, Australia's most famous online education portal for a wide range of teachers. After searching the required resource catalog on the website, the visitor will connect to the website storing the information of these resources through the name index of these resource catalogs.

The focus of the Canadian Education Project and its development is to create a network of teaching and learning resources based entirely on metadata standards as the main framework by updating teaching and learning resources. Another Careo project in Canada is an educational reference site for multilingual subjects that can be accessed free of charge at any time via the Internet. CAREO pays special attention to modular use of learning resources, reuse of resource content, and standardization of learning resource metadata.

3. Method Research

3.1. Collecting and Sorting Models. In view of the problems existing in the construction of the existing teaching resources database and the specific needs of the existing electronic teaching system, this chapter proposes a structured teaching resources collection and collation method based on the focused crawler technology. It can realize automatic online collection and collation of teaching resources in specific fields on the Web.

The main idea is as follows: first, the teaching resources are trained by using the method of learning from the topic classification structure table, and the characteristic items of the teaching resources of each topic are extracted. At the same time, the common sense and domain knowledge related to the theme are summarized. Then, using this knowledge, the focused crawler is guided to search and collect relevant thematic Web pages on the Web. After the web page information containing structured teaching resource information is successfully captured by the search engine, the technology of structured data extraction is applied to further extract and screen out all the structured web page teaching subject resources actually containing information content, and form a structured file. Finally, all of these files are stored in subject and architecture categories. The index function such as the index table should be established to facilitate query retrieval and retrieval. The model mainly consists of the following parts: focused crawler based on ant colony algorithm, automatic clustering, data extraction, and structured repository engine. A good automatic resource collection and organization model is the basis for improving the quality of the teaching resource library, and each part of the method will be introduced in detail below in Figure 1.

3.2. Focused Crawler Based on Ant Colony Algorithm. The overall distribution of information resources in the Web search space is unknown to focus on crawlers, so it is impossible to predict their creeping direction.

Ant colony algorithm technology, not only can simultaneously support a variety of intelligent algorithm search, global performance and optimization, but also has its own sets, positive feedback, distributed computing, and many other features, easy to quickly combine with other advanced algorithm technology. The use of the positive feedback principle can help further accelerate the overall speed of the evolution of human-computer intelligence development;

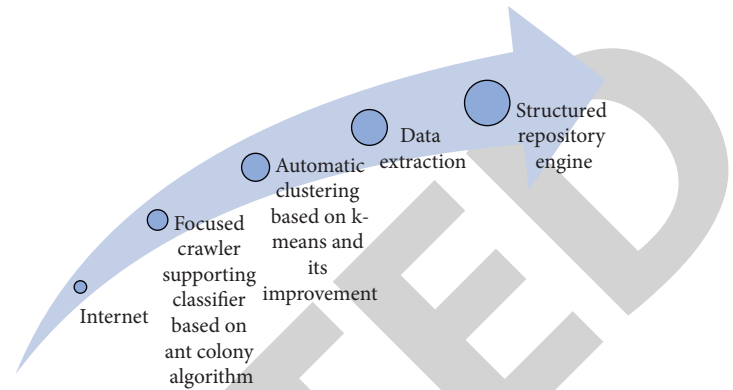


FIGURE 1: The process of building a multimedia English teaching resource library.

distributed parallel computing system facilitates high-speed parallel analysis and rapid execution between various complex system algorithms, and it is easier to carry out high-speed and continuous real-time exchange and sharing of data between the members of the personal computer system, which facilitates the user to quickly find and design the best solution with higher overall performance. It is also easier to fall into the misconception of optimizing the local performance of the system; an easy combination of heuristic algorithms can improve its performance; therefore, variations based on the ant colony algorithm model can be used to solve other problems.

The literature points out that it is much more effective to use topic classifiers to guide a website's commitment to crawl sliders.

In view of the above, we propose a focused crawler module based on the ant colony algorithm using classifier architecture by introducing the ant colony algorithm into the focused crawler search strategy and using the "inspiration" of the ant colony algorithm to guide the focused crawler on the Web.

The core of this module is the design of the focused crawler and the classifier (subject feature item library and knowledge base). The classifier in the focused crawler is mainly responsible for training the behavioral characteristics of the crawl target, calculating the relevance of the target web pages, and classifying the web pages. This module actually also enables the downloading of resources, the automatic filtering of URL content (using heuristics to filter out unwanted URLs), and the automatic filtering of web page content (it also enables the horizontal comparison of the relevance value of the result obtained from the calculation with the threshold value of the given automatic filtering, and if the value is greater than the threshold value, the links are retained and extracted, and the new links are continued to be tracked, otherwise they are discarded). Otherwise, they are discarded).

The web crawling sub-module undertakes the task of connecting the URL evaluation sub-module with the topic relevance analysis sub-module. This module first selects the URLs with the highest hyperlink scores in the URL link seed

set discerned from the URL evaluation sub-module and fetches the corresponding web pages. The web pages are divided into authoritative Hub pages and Content pages. Hub pages, i.e., directory pages, provide users with topic-related websites, and only extract URLs and anchor texts, without entering the topic relevance analysis sub-module, because it must contain many classes. Content pages are entered into the analysis sub-module of topic relevance for processing.

The website subject relevance analysis subtype (sorting module) crawl subproject is loaded, and the relevance to the subject is determined by focusing on the crawler through the subject relevance analysis subtype, thus guiding the subsequent crawler access process. After loading the page, if the value exceeds the threshold of one or more classes, it will be saved to the corresponding class, otherwise, it will be discarded. Fast and accurate access to structured data and metadata information on relevant topic websites is the basis for assessing and classifying the meaning of a topic. The so-called structured data and metadata are key information fields extracted from information sources. The specific approach can be based on keywords (feature elements) or can be traced back to the semantic and conceptual level [9]. The main idea of keyword-based thematic relevance analysis is, first, to determine the structure of the thematic classification system, with the participation of experts in the field; second, the classification system focuses on the taxonomy in reptiles, i.e., the taxonomy of reptiles. E.Education prepared the sample with the participation of experts in this field, identifying a set of features with weight, reflecting the characteristics of a specific field, identifying specific topics, and forming a feature and knowledge base that provides the basis for a targeted collection of information on reptiles. This is followed by linking to URL strings, text on anchors (the advantage of links and web links is that links describe the text more accurately than the page itself, and links describe the text linked to the page, an operation that helps to search for non-textual information), or extracting the page text by keyword [10]. Finally, the page topic is calculated to derive the relevance of the page content to the website topic and determine the threshold value, which determines the page trade-off [11]. The basic principle of the vector space model algorithm is that by converting a text space of a given form (article, query or paragraph in an article, etc.) into a text vector of high spatial dimensionality, and then using their corresponding operator formulas, respectively, the degree of similarity in size between any two of their text vector spaces is calculated, i.e., the correlation in size between the text vector and the two text vectors to which the corresponding operation is to be applied.

The URLs evaluation submodule is used to evaluate the relevancy of URLs parsed from topic-related pages and guide the crawling process of focused crawlers using the ant colony algorithm.

3.3. Automatic Clustering. Clustering is an important analysis method in data mining, which has been widely used in business intelligence, Web mining, and other fields. The clustering module can automatically sort the teaching

resources of specific topics collected by web crawlers, reduce manual labor and improve sorting efficiency [12].

The clustering algorithm is a classification process that divides each population into several completely different levels according to the differences in data characteristics between different population levels by using computer technology. The main algorithm principle of clustering analysis of individual data distribution is to make the average data distance between two categories of the same individual population as small as possible, and to make the average data distance between two categories as large as possible. The k-means algorithm and the recent neighbor algorithm are the most flexible, stable, and reliable algorithms in the research of clustering algorithm, and the most flexible and widely applicable in the field [13]. In the K -means algorithm, n target points are considered to be divided into K target clusters. First, a representative target point with at least K targets is selected, and according to the minimum relative distance between it and other representative points, all target clusters of other categories can be considered to be re-divided into another target. Therefore, each class is represented by its center of gravity, and the other objects are re-segmented. This process is performed iteratively until convergence occurs. K -means algorithm has a simple structure and is easy to implement quickly, with higher efficiency and linear time complexity. In addition, it can always converge to the local optimal from the search to the initial position of the object, but the number of cluster centers at the specified position must be calculated in advance [14]. The initial location of cluster analysis center has a great influence on the result of cluster analysis. This is actually a deterministic local search algorithm.

PSO algorithm is a global optimization algorithm based entirely on the characteristics of the population. Its inspiration partly comes from the simulation of the foraging behavior of the bird population. Although the algorithm has a fast convergence speed, it can easily fall into the approximate local optimal solution [15]. When it converges completely to a nearly global optimal solution, the overall accuracy of the solution may be difficult to improve further [16]. The intelligent single particle algorithm proposed in the literature can not only ensure that a single particle can randomly search each region in the search space but also can effectively decompose the single search space into at least several small areas, small particle size search space, so as to better solve the problem of PSO algorithm. Combining k -means algorithm with an intelligent single particle algorithm, an improved ISPO + K -means hybrid clustering algorithm is proposed [17]. The basic processing flow of the automatic clustering module is shown in Figure 2. See Chapter 4 for details.

3.4. Data Extraction. After the access to the user-related structured information content, according to customer's demand, also need to automatically extract calculate the related structured web page information in the data, the user information stored on that particular page specific content of the page data, by automatically extracting method,

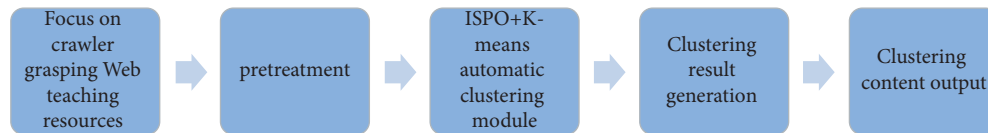


FIGURE 2: Processing flow of automatic clustering module.

structured information data is converted to a particular web page [18]. The structured database is regarded as a relatively small storage unit in the system, and these structured data are stored and processed separately according to the data classification principle of the information subject system and the design of the information architecture. You also need to build indexes and other functions for queries and recovery. Therefore, the data extraction module came into being [19]. The data extraction module is to extract and sort the theme-related web pages collected by the crawler according to format and category. In order to realize the fast and accurate extraction of web content rules and the fast and effective integration of various web data from various web resource environment systems under different levels of use, we need a specially constructed web wrapper library. The main content of the wrapper is to extract the extraction rule code base from each page of website content and a computer program code base that can effectively apply the extraction rule code embedded in all websites. Wrappers should be able to retrieve relevant information from specific information sources and integrate information from different information sources into a database. Web page data extraction system generally adopts the form of plug-in [20]. Through plug-in management services, different plug-ins are used to process web pages with different structures. The advantage of this approach is that it is extensible: in the future, whenever a new type appears, its processing methods can be transformed into plug-ins and added to plug-in management services [21].

The classification module automatically classifies subject-related web pages, stores and maintains them according to the classification structure, and serves as the input of the data extraction module. The data extraction module formulates the corresponding extraction rules and modes according to the characteristics of each discipline field and the learning of the sample web pages marked by experts and generates the corresponding wrapper library. The data extracted by the wrapper is stored as an entity file (Structuralfile) according to a pre-set format, using XML to represent it. It is then processed by the structured repository engine module and stored in the structured repository. As the new structured files are populated, the new feature items are periodically or quantitatively retrained and added to the feature item library of the classification sub-module. This makes the classifiers built in the classification sub-module adaptive [22]. The method of obtaining extraction rules and patterns in the wrapper also has a self-learning function, and the extraction rules and patterns are continuously improved as new samples appear.

There are two kinds of extraction rules and patterns used in the wrapper system design procedure. One main

approach is to use manual methods to prepare extraction rules and procedures directly so that the wrapper system can effectively deal with several specific types of knowledge information extraction-related problems at the same time, which is called the extraction knowledge engineering method [23]. The other one is to learn the extraction rules of the marked corpus and then process the new text through training or learning, this method is called the automatic recognition pattern method, the advantage is fast, but the disadvantage is the high requirement for training data. In this study, we propose to use the two methods, knowledge engineering and automatic recognition mode, together.

3.5. Structured Teaching Resource Library. The collection and arrangement of network teaching resources is a continuous and evolving process [24]. The continuous updating of teaching resource standards and requirements requires the teaching resource library to be constantly supplemented and updated timely and automatically; without unified teaching material standards, the downloaded resources cannot be effectively stored in a structured manner and cannot form an effective utilization scheme, thus making it difficult to realize the ease of use, sharing and It is difficult to realize the ease of use, sharing and expandability of online teaching resources. To address these problems, we propose the concept of creating a structured teaching resource library [25].

The structured teaching resource library is defined as a teaching resource library that is built based on structured metadata information related to the topic and pays more attention to specialized application and structural analysis, and these structured metadata have well-defined syntax and clearly defined semantics, which can reflect the status and characteristics of teaching resources in an integrated manner [26].

The structured teaching resource library is based on a certain classification system structure. The classification system structure includes concepts, ontologies, knowledge points, etc. At present, most structured teaching resource libraries are built on the common classification system structure of specific disciplines, which is usually a tree structure. The first-level directory is the main content within the subject (usually corresponding to the chapter of the textbook); the second-level directory is the main knowledge points under this content; the third-level directory is the common types of resources used under this knowledge point (e.g., courseware, materials, exercises, extensions, lesson preparation reference, etc.); the fourth-level directory is the form of resource media presentation (text, pictures, sound, images, etc.); and the fifth-level directory is the specific resources [27]. The nodes at each level of the directory

provide corresponding functions, for example, the functions of adding, deleting, modifying, copying, moving up and down, and exporting of nodes; the functions of limiting the total amount of resources; and the functions of limiting the types of applications of resources.

4. Algorithm Experiment

4.1. Particle Swarm Algorithm. The particle swarm algorithm is a swarm intelligence optimization algorithm proposed by Kennedy and Eberhart in 1995, inspired by the foraging behavior of bird and fish flocks. In the particle swarm algorithm, it is first initialized as a swarm of random particles, the position of each particle represents a candidate solution, and the degree of superiority of the solution is determined by the fitness function. In each iteration, the particle updates the velocity and position of that particle by dynamically tracking the individual extremum p_{best} and the global extremum g_{best} . The p_{best} represents the optimal solution found by the particle itself, while the g_{best} represents the optimal solution found so far by the whole population. The iterative search is terminated by reaching a specified number of iterations, or by the positions searched so far satisfying a specified error criterion.

In the PSO algorithm, the particle population is searched in a D -dimensional space, and if a population is formed by n particles, the position vector of the i th particle ($i = 1, 2, \dots, n$) is noted $z_i = (z_{i1}, z_{i2}, \dots, z_{id}, \dots, z_{iD})$ as. The superiority of the particle position is calculated and measured according to certain criteria [28]. The velocity vector of particle i is the distance moved by the particle in each iteration, $v_i = (v_{i1}, v_{i2}, \dots, v_{id}, \dots, v_{iD})$ denoted as, the optimal position searched so far by the i th particle is p_{best_i} , the optimal position searched so far by the whole particle population as, g_{best} , then the update velocity of the d th dimensional component of any particle i in the PSO population at the $k + 1$ th iteration is determined by equation (1), [29].

$$v_{id}^{k+1} = w v_{id}^k + c_1 r_1^k (p_{id}^k - z_{id}^k) + c_2 r_2^k (p_{gd}^k - z_{id}^k). \quad (1)$$

The update speed of the particle is composed of three components, the first term is the inertia weight term, which remembers the effect of the particle's previous movement speed; the second term is the cognitive term, which represents the effect of the historical optimal position of the particle population; and the third term is the social term, which represents the effect of the optimal position once possessed by the particle population.

The position of the particle after moving is determined by equation (2), i.e., the sum of the position and movement at the previous moment is

$$z_{id}^{k+1} = z_{id}^k + v_{id}^{k+1}, \quad (2)$$

where k is the number of iterations and r_1 and r_2 are random numbers uniformly distributed between $[0, 1]$. c_1 and c_2 are the learning factors. The particles keep following the guidance of local optimization and global optimization to

search in the search space until the number of iterations is reached or the error threshold is satisfied [30].

4.2. Intelligent Single-Particle Algorithm. In the traditional PSO algorithm, the overall quality of the solution vector is often judged by changing the values of each dimension in the whole solution vector simultaneously and getting an adaptation value based on the updated solution vector. However, this does not tell whether the partial dimension moves in the optimal direction. To address this problem, the literature proposes the solution of dividing the particle into several small spaces of lower dimensions for searching while ensuring that it can search the whole space. The basic idea is as follows.

The algorithm uses a particle to search in the solution space, and the position vector of the particle is divided into several subvectors, and then the particle is updated by the subvectors. In the process of subvector updating, a new learning strategy is introduced by analyzing the previous velocity updates, so that the particle can dynamically adjust its velocity and position in the search space, thus approaching the global optimum.

The algorithm principle is described in detail as follows.

The first is the subvector. Unlike the traditional particle swarm algorithm, in the intelligent single-particle algorithm, each particle represents the entire position vector, and when updated, the entire D -dimensional space is divided into m parts, i.e., the entire position vector is divided into m position subvectors, and each position subvector and its corresponding velocity subvector are denoted as and, $j = 1, \dots, j, m$, v_j respectively. For simplicity, assuming that D is exactly divisible by m , each position subvector l ($l = D/m$) includes a dimension.

The second is the update process. The update process of the intelligent single-particle algorithm is that each position subvector is updated cyclically from \bar{z}_1 in \bar{z}_m sequential order, and the iterations are executed N times, and the speed and position adjustment equations at update are as follows:

$$\begin{aligned} \bar{v}_j^k &= \left(\frac{a}{k^\rho} \right) \times r + b \times L_j^{k-1}, \\ \bar{z}_j^k &= \begin{cases} \bar{z}_j^{k-1} + \bar{v}_j^k, & f(x_1^k) > f(x_2^k), \\ \bar{z}_j^{k-1}, & f(x_1^k) \leq f(x_2^k), \end{cases} \\ L_j^k &= \begin{cases} \frac{L_j^{k-1}}{s}, & f(x_1^k) \leq f(x_2^k), \\ \bar{v}_j^k, & f(x_1^k) > f(x_2^k), \end{cases} \end{aligned} \quad (3)$$

where the parameter L denotes the learning variable, r denotes a random vector uniformly distributed on the interval $[-0.5, 0.5]$; the constants $a, \rho, b \geq 1s$, and (b) denote the diversity factor, descent factor, contraction factor, and acceleration factor, respectively; and $f()$ is the adaptation value function.

During the subvector update process, the velocity subvector determines the position subvector, and each velocity subvector consists of two parts: the learning part $b \times L_j^k$ and the diversity $(a/k^p) \times r$ part. The diversity $(a/k^p) \times r$ part decreases with the increase of iterations, which will make the particle dynamics gradually switch from global search to local search.

Third is the learning strategy. The intelligence of the ISPO algorithm is mainly reflected in its learning part. It follows a new learning strategy that uses the learning part of the velocity $b \times L_j^k$ subvector to intelligently adjust the velocity subvector according to the previous velocity updates of the particles so that the velocities of the particles have greater diversity and thus avoid falling into local optima.

The final intelligent single-particle algorithm pseudo-code can be obtained.

4.3. K-Means Algorithm. So far, researchers have proposed or designed a variety of classical document clustering algorithms for this purpose, among which the K -means algorithm is a classical algorithm that can really solve the problems of clustering and analysis of complex documents quickly. The K -means clustering algorithm is based on the distribution of the probability predictions of the category categories of the most similar documents.

The K -means clustering algorithm works as follows: first, K clusters are selected as the initial center of mass, where K is a pre-specified cluster parameter, i.e., the number of cluster points expected by the user. Each point is assigned to the initial center of the nearest cluster, and each cluster assigned to the initial center is automatically clustered into the next cluster. Then, the center of mass of each cluster is updated according to the points assigned to the cluster. The two steps of assigning and updating are repeated until the clusters do not change anymore, or are almost identical, and the center of mass does not change. The specific steps are as follows.

Input: N documents to be clustered, number of clusters K .

Output: K clusters and convergence of the criterion function.

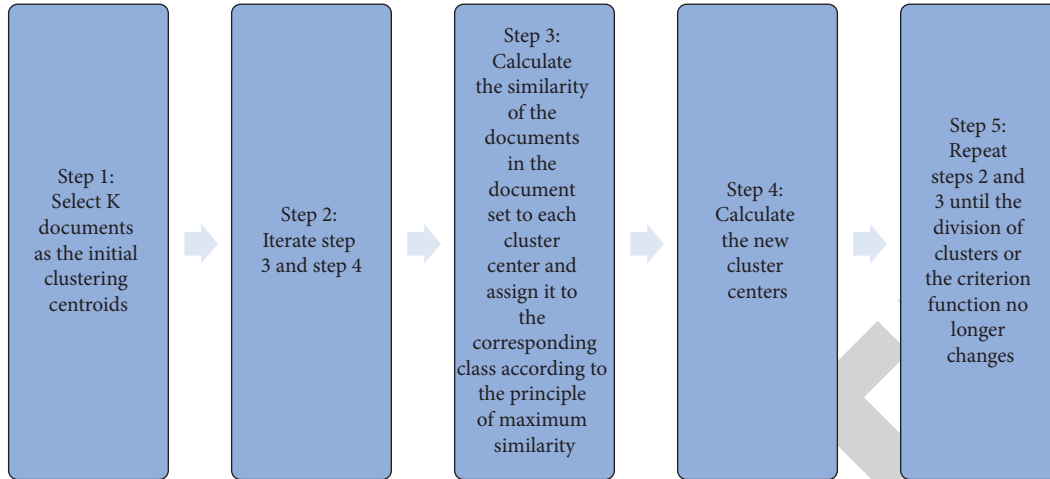
The method is shown in Figure 3.

The K -means algorithm is simple, effective, and fast to process, especially for large document sets. However, the traditional K -means classification algorithm has two inherent drawbacks: (1) random initial value selection may lead to different clustering results, and even the existence of no solution and more sensitive to the initial clustering center; (2) the algorithm is based on gradient descent algorithm, so inevitably often fall into the local optimum. These two major defects greatly limit its application scope.

4.4. Improved K-Means Algorithm Based on Intelligent Single-Particle

4.4.1. ISPO + K-Means Algorithm Idea. To overcome the above-mentioned shortcomings, many studies in recent years have combined the Particle Swarm Optimization (PSO) algorithm to improve the K -means algorithm. Omran et al. first applied the particle swarm algorithm to cluster analysis in 2002 and showed experimentally that the clustering effect based on the particle swarm algorithm is better than the simple K -means clustering algorithm. According to the literature, k -means should be combined with particle swarm for clustering, and it is proposed that in the initialization stage, the fast clustering results of K -means should be used to initialize and assign values, and then the clustering algorithm of particle swarm is used. In the literature, random functions were used to allocate the initial positions of particles in the initialization process, and then the k -means clustering algorithm was used for optimization in the subsequent new generation of particles. A method of spatial clustering analysis with obstacle constraints combining PSO algorithm and partition is proposed in this study. This method makes good use of the global solution searching ability of the particle swarm optimization algorithm and fully considers the effect of real obstacles on the clustering results so that the clustering results are more practical. DKPSO, a dynamic clustering algorithm based on particle swarm, is proposed in this study, which can automatically determine the optimal number of clustering centers when running. In the literature, k -means calculation is performed on all particles in each PSO iteration to seek the optimal solution. Although the clustering performance is improved, the algorithm still fails to get rid of the dilemma that the PSO algorithm falls into the local optimal solution, but greatly increases the computational amount of the algorithm, resulting in slow convergence. The Adaptive particle swarm optimization (APSO) algorithm proposed in the literature can estimate different evolutionary states of the algorithm, and design an effective parameter Adaptive control strategy according to the different evolutionary states, so as to speed up the solution of the algorithm optimization problem.

The clustering methods of combining the PSO algorithm with the K -means algorithm described in the above literature can be divided into three categories: k -means first followed by particle swarm optimization can be simply written as K -means + PSO; PSO first followed by k -means can be written as PSO + K -means; The recombination of the above two types is abbreviated as K -means + PSO + K -means. Literature has proved through experiments that the latter two combination methods have better effects, and the probability of obtaining the best solution is significantly higher than the k -means method, basic PSO method, and K -means + PSO method. The study analyzes the problems existing in the traditional PSO algorithm, proposes the

FIGURE 3: k -means algorithm flow.

intelligent single particle optimization algorithm, and proves through experiments that the algorithm can overcome the defects of the traditional PSO algorithm. In view of this, the intelligent single particle optimization algorithm is introduced into the clustering analysis, and an improved particle swarm and K -means hybrid clustering algorithm ISPO + K -means is proposed.

The ISPO + K -means clustering algorithm proposed in this study consists of two modules: the ISPO module and the K -means module. First, the ISPO algorithm is used to find the optimal m initial clustering centers, then the k -means algorithm is used to find the clustering results, and finally, the clustering results are output. The m initial clustering centers found by the ISPO algorithm means that M initial clustering centers are randomly given for the k -means algorithm. In the subsequent execution steps of the algorithm, the optimal one is selected from m kinds of clustering, so that the defect of the k -means algorithm sensitive to the initial clustering center can be significantly improved.

4.4.2. ISPO + K -Means Algorithm Coding and Fitness Function. ISPO + K -means clustering algorithm adopts the coding method based on clustering centers. Each particle is encoded with location, velocity, and adaptive value. The dimension of the sample vector is D and the number of clustering centers is M , so the location and velocity of particles are $m \times D$ -dimensional variables and the adaptive value function is $F()$.

4.4.3. ISPO + K -Means Algorithm Description in Detail

(1) ISPO Module

Step 1: given data $D = (x_1, x_2, \dots, x_n)$ set, z^0 represented as position vector of data set D . The entire position vector is divided into m position subvectors, i.e., $z^0 = (\tilde{z}_1^0, \tilde{z}_2^0, \dots, \tilde{z}_m^0)$ and the fitness is $f(z^0)$ calculated.

Step 2: initial number of sub-vectors $j = 1$ and learn $L_j^0 = 0$ variables.

Step 3: initial sub-vector iterations $k = 1$. If the maximum number of iterations N is reached, skip to Step 4; otherwise, continue. Update the speed of the J TH subvector according to formulas (5-3) and (5-5). Update the position of the J TH subvector according to formula (5-4).

Step 4: perform the next subvector according to Step 2 and Step 3. If all the m subvectors are updated, skip to step 5. Otherwise, continue the execution.

Step 5: output the center point values of m clusters.

(2) K Means the Module

Step 1: take the values from I $x_i \in D = 1$ to n respectively, and then find the center point from the m cluster centers selected by ISPO module according to O_j the nearest x_j neighbor rule, and C_j add clustering.

Step 2: recalculate the center points of each new cluster, $j = 1, 2, \dots, M$, O_j that is, calculate the average value of the members of the new cluster and use this average value as the center point of the new cluster.

Step 3: repeat Step 2 and Step 3 until there is no change in each clustering center, that is, the algorithm converges, and the final clustering result is output.

4.5. ISPO + K -Means Algorithm Experimental Design. All experiments were carried out on a PC with CPU 2.0 GHz and 1G memory, operating system Windows XP and Matlab 6.5. The experiment evaluates the clustering performance of low-dimensional data, high-dimensional data, and multidimensional sample high-dimensional data sets, respectively. We compared the experimental results of ISPO + k -means with those of PSO + K -means and K -means.

Three kinds of data sets commonly used in similar studies were used for experimental data: The low-dimensional feature data set was the Iris plant sample data

TABLE 1: Parameter Settings of is PO + K-means algorithm.

The data set	a	b	p	l	s	ϵ
Iris	15	2	40	1	4	1.00e+00
Winc	300	2	3	1	4	1.00e+00
Cancer	2000	2	40	1	4	1.00e+00

TABLE 2: Comparison of stability of three k -means clustering results.

Data set	Iris		Winc		Cancer	
	Mean	Variance	Mean	Variance	Mean	Variance
k -means	33.1022	9.5668	140.1022	38.5623	701.1236	331.1211
PSO + k -means	12.9673	4.0006	71.1389	5.1363	271.8983	44.9673
IPSP + k -means	11.7652	3.9362	62.4187	3.1364	206.3255	16.2147

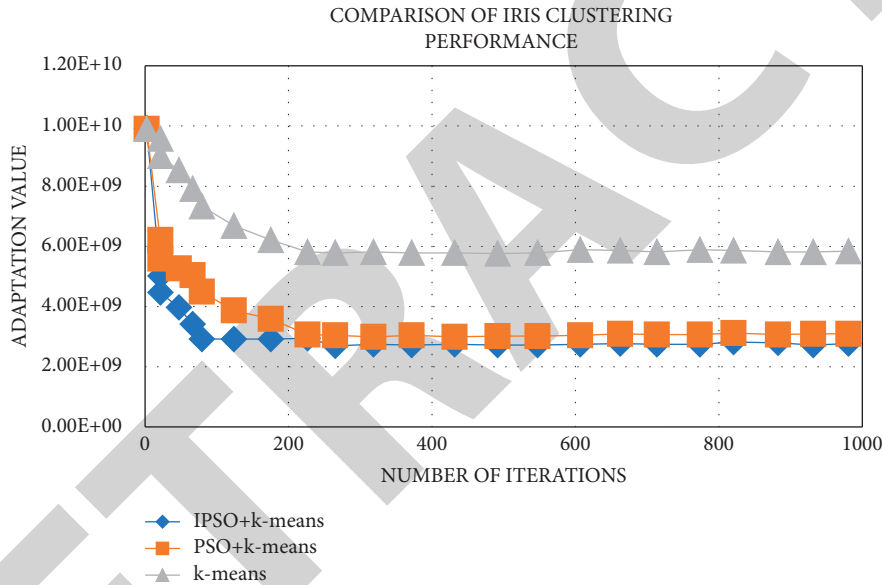


FIGURE 4: Comparison of IRIS clustering performance.

set, which was divided into three categories with four attributes for each data object and a total of 150 samples. The high-dimensional feature data set adopts the Wine data set, which is divided into three categories. Each data object has 13 attributes and 178 samples in total. The WisconsinBreastCancer dataset was used for the multiple high-dimensional data, which was divided into two classes with nine attributes for each data sample, a total of 663 samples.

In the experiment, the value of the adaptive function $f()$ is the function value corresponding to the current position. Parameter Settings of the K -means algorithm and PSO + K -means algorithm are referenced. Table 1 describes the parameters of the ISPO + K -means algorithm.

4.6. ISPO + K -Means Algorithm Experimental Results Analysis. The clustering experiment results are shown in

Table 2 and Figures 4–6. It can be seen from Figures 4–6 that the k -means algorithm has the fastest convergence speed, but it is easy to fall into local optimal. By combining PSO + K -means clustering algorithm with the traditional particle swarm optimization algorithm, the global optimal solution searching ability of the algorithm is improved. However, as the number of iterations increases and the effect of k -mean decreases, the particle swarm focuses and converges gradually, and then falls into the local optimum. Different from the above two methods, the ISPO + K -means algorithm proposed in this study does not update the whole velocity vector or position vector at the same time as the traditional PSO at the ISPO stage. Instead, it divides the whole vector into several sub-vectors and updates the sub-vectors at the same time. By introducing a new learning strategy, the particle can make an intelligent analysis of its previous velocity update and determine the velocity of the next iteration, thus increasing the velocity diversity and making it

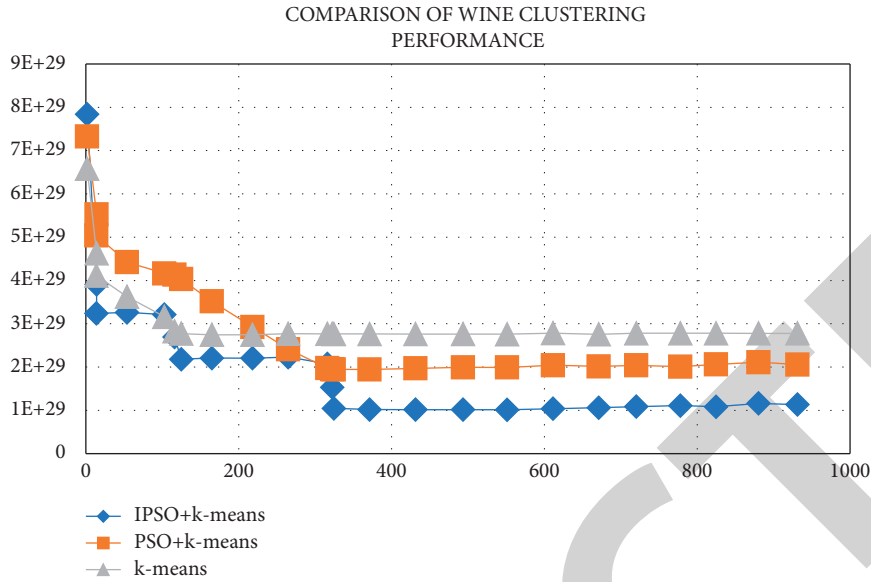


FIGURE 5: Comparison of clustering performance for WINE.

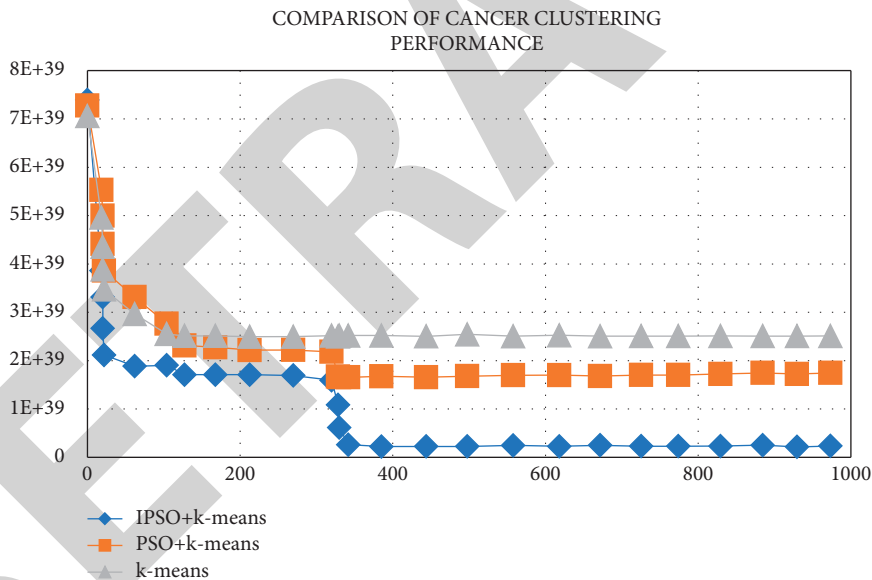


FIGURE 6: Comparison of clustering performance for CANCER.

easy to jump out of the local optimal and approach to the global optimal.

The comparison results of data clustering stability of the three algorithms are shown in Table 2. It can be clearly seen from the sub-variance value and mean difference of the above algorithms that the stability of the k-means algorithm is often extremely poor due to the large influence range of the initial solution, and it is very easy to cause the calculation results to fall into local optimal. The PSO + K-means hybrid clustering algorithm system is a k-means operation introduced at least once in each iteration of the algorithm, which makes the system algorithm in the initial stage of the entire iteration can always have a good and stable processing ability

of distribution search results of global initial solutions. Therefore, the algorithm architecture itself greatly reduces the dependence of the algorithm on the global initial solution distribution search results, and the stability of the overall structure of the algorithm is relatively good. The proposed algorithm ISPO + K-means has no obvious advantage in processing low-dimensional feature data. However, in fact, it is difficult for the traditional PSO algorithm to take into account all the optimization directions of low-dimensional space when dealing with the problem of high-dimensional and diverse particle feature data. The ISPO + K-means algorithm proposed in this study decomposes the large particle search space into several low-dimensional

small Spaces in an ISPO module. And updated throughout the particles in the process of iteration, the introduction of some new learning optimization strategy, through the analysis of the real-time particle velocity and the update of the before, intelligent quickly achieve the real-time dynamic optimization to solve the speed adjustment, enhance to improve the global solutions for computing performance in the field of space exploration, making global algorithm significantly less dynamic dependence on initial solution speed. The dynamic stability of the algorithm is greatly improved. As can be seen from the mean and variance values shown in Table 2, the algorithm proposed in this study has obvious advantages in processing high-dimensional feature data, especially for complex and diverse high-dimensional feature data, and its performance is greatly improved compared with other algorithms.

Compared with the other two algorithms, the ISPO + K-means algorithm has the highest efficiency in terms of time, because K-means does not perform PSO optimization and clustering directly. Compared with PSO + K-means clustering algorithm, ISPO + K-means algorithm does not update all spatial dimensions at the same time, which greatly reduces the iteration time of the algorithm, especially in processing high-dimensional data.

In this chapter, the automatic clustering based on the previously proposed method is studied. Based on a full understanding of the clustering technology, the analysis of the classical clustering algorithm *K*-means algorithm and particle swarm algorithm, the hybrid clustering algorithm combining intelligent single particle and *K*-means algorithm is proposed for the problem that the particle swarm algorithm is prone to fall into the local optimum and the two inherent defects of *K*-means algorithm--ISPO + K-means clustering algorithm, including two modules: ISPO module and *K*-means module. The ISPO algorithm is used to find the optimal *m* initial clustering centroids; the *K*-Means algorithm is used to find the clustering results, and finally, the clustering results are output. The experimental results show that the proposed algorithm overcomes the problems of the above algorithms better, especially for the clustering of high-dimensional data.

5. Summary and Prospect

This thesis summarizes the current situation and problems of multimedia English teaching resource library construction, and the main content is to focus on the use of existing information technology as a means to carry out research related to the construction of the resource library. This chapter concludes the thesis with a specific summary of the main work and innovation points of the previous study, and also makes the corresponding construction and outlook for the next work and research direction.

5.1. Summary. The research content and main innovations of this study are mainly as follows: in view of the defects and shortcomings of some current teaching resources construction, a model is proposed to collect and automatically

organize the rich teaching resources on the network by using existing information technology. The overall architecture of the model and the design ideas of each module are also described. In addition, this study proposes a hybrid automatic clustering algorithm ISPO + K-means and K-means clustering algorithm and compares it with the traditional particle swarm *K*-means-based hybrid algorithm. The results show that the proposed algorithm can effectively overcome the problem that other algorithms tend to fall into local optimality, and verify that the algorithm has obvious advantages in processing multi-dimensional data sets.

5.2. Prospect. In the process of resource construction and management in the teaching field, we need tools for collecting, organizing, and retrieving various subject-specific resources, how to collect, organize and store the resources by using existing IT technologies? This requires us to integrate various technologies to form an automatic structured teaching resource collection (collection) and organization (process) method. This study mainly starts from the perspective of the current situation of teaching resources, and puts forward the corresponding collecting and organizing methods for the shortcomings and deficiencies in the current process of constructing multimedia English teaching resources library, due to the limitation of time, objective conditions, and our own ability, the study only does relevant research on part of the method, and the follow-up work can be carried out from the following aspects.

First, the other parts of the proposed automatic collection and collation method will continue to be studied. This includes data extraction, formation of structured resources, and development of a structured repository engine.

Second, optimize the proposed ISPO + K-means automatic clustering algorithm and try to further successfully improve the execution efficiency of the algorithm as well as the accuracy of the final clustering results.

Third, the model can be continuously improved and enhanced for this model, and a prototype system can be developed to make it more widely used in the field of resource search and organization.

Data Availability

The labeled dataset 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

This study was supported by the following projects: A Probe into the Mode Teaching of How to Make the English Study and Moral Education Integrate Based on the Internet in the Ethnic Tibet-Related Areas (No.SCJG21D021) and To Construct the Integration of Ideological, Political Course into College English in Ethnic Tibet-Related Areas (No.WYJZW-2021-2145).

Retraction

Retracted: A Low-Latency and High-Throughput Multipath Technique to Overcome Black Hole Attack in Mobile Ad Hoc Network (MTBD)

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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] D. Ramachandran, S. S. V. Rajeev Ratna et al., “A Low-Latency and High-Throughput Multipath Technique to Overcome Black Hole Attack in Mobile Ad Hoc Network (MTBD),” *Security and Communication Networks*, vol. 2022, Article ID 8067447, 13 pages, 2022.

Research Article

A Low-Latency and High-Throughput Multipath Technique to Overcome Black Hole Attack in Mobile Ad Hoc Network (MTBD)

Dhanagopal Ramachandran ¹, Sasikumar S ², Vallabhuni Rajeev Ratna ³,
Vijayprasath S ⁴, Suresh Kumar R ¹, Vasanth Raj P T ¹, Ilhan Garip,⁵
and Umamaheswari K ⁶

¹Centre for System Design, Chennai Institute of Technology, Kandrathur, Chennai, India

²Department of ECE, Hindustan Institute of Technology & Science, Kelambakkam, Tamil Nadu, India

³Application Developer, Bayview Asset Management, LLC, Coral Gables, FL, USA

⁴Department of Electronics and Communication Engineering, PSNA College of Engineering and Technology, Dindigul, Tamil Nadu, India

⁵Department of Electrical and Electronics Engineering, Nisantasi University, Istanbul, Turkey

⁶Kebridehar University, Kebri Dehar, Ethiopia

Correspondence should be addressed to Dhanagopal Ramachandran; dhanagopal.phd@gmail.com and Umamaheswari K; uma@kdu.edu.et

Received 2 June 2022; Revised 29 June 2022; Accepted 28 July 2022; Published 25 August 2022

Academic Editor: Tao Cui

Copyright © 2022 Dhanagopal Ramachandran et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Security in MANETs is a highly contentious topic in the field of network management. The availability and functionality of a MANET might be compromised by a variety of attacks. One of the most prevalent active attacks used to degrade network speed and reliability is the black hole attack, which leads the compromised agent to discard all data packets. The purpose of a black hole node is to trick other access points into thinking that they must use their node as their route to a certain destination. The black hole node in a cable network cannot be detected or eliminated in an AODV network. We improved AODV in this study by utilizing a lighter-weight technique based on timing and baiting for detecting and separating single and collaboration black hole attacks. MANETs have a dynamic topology, an open medium, and a lack of a highly centralized monitoring point, all of which offer security problems. Attacks on security are one of the sorts of attacks. In MANETs, it has no central administration, and mobile devices link to other devices wirelessly. Black holes, insider attacks, gray holes, parallel universes, faulty nodes, and packet drops are all threats that can cause considerable disruption in secure communication. Simulation findings demonstrate that the proposed method significantly outperforms previous techniques in terms of end-to-end delay, throughput, packet delivery ratio, and average energy. A multipath methodology is used in our proposed method to mitigate the black hole attack in MANET. The proposed technique is tested in a simulation reality to see how stable it is in the face of an attack. When the proposed method's results are compared to those of existing state-of-the-art approaches, it is discovered that the acquired results are satisfactory.

1. Introduction

MANET is a self-contained system in which nodes/stations connect with one another using wireless networks. The ability of nodes to connect to or leave the system is unfettered; hence, node connectors may depart at whim. MANET design is dynamic and may change fast with impact on the nodes' capacity to transmit freely and order them arbitrarily. Because

of this attribute of the nodes, the MANETs are unpredictable in terms of durability and topology.

MANET is a Wi-Fi ad hoc network, wherein the nodes are permitted to move around at will and mobile nodes can send and receive data. Also, because wireless routers are multiple hop devices, wireless routers are operated by mobile nodes by forwarding traffic from other nearby nodes to the location node shown in Figure 1. MANET does not require wired

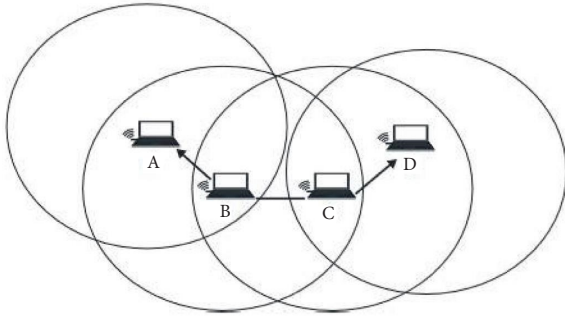


FIGURE 1: MANET.

facility platform channels. Network clients of Wi-Fi will connect mobile nodes with a self-organized network. Without any established infrastructure or central control, the mobile nodes instantaneously produce a network.

Wireless sensor networks (WSNs) are a major topic in communications research right now. Tiny-structured sensors with limited resources are getting easier to improve. In addition, they appear to be able to perceive the environment's parameters, gather important data, and communicate this knowledge to the user. When it comes to implementing the 4.0 industrial revolution, intensive research is needed to ensure that the Internet of Things (IoT) works properly [1]. Ad hoc networks do not have a central access point, but infrastructure-based networks have. Due to its wireless nature, a mobile ad hoc network (MANET) can be established as a multihop packet network with no fixed infrastructure [2]. The packet sizes, data rates, transmission ranges, and speeds of these nodes and devices might vary widely. Autonomous, multihop, and dynamic topology are just a few of the MANET's distinctive features. Other issues such as packet loss, security, and QoS are also present in these networks. The establishment of basic connection among distinct nodes necessitates the use of routing mechanisms.

Even if the attacker node does not truly have the quickest path to any targeted network node, all packets will still travel through it, giving the black hole node the ability to forward or reject packets while the data transmission is still in process. An active attack type is black hole attack. The black hole node takes advantage of the fact that every response from an ordinary node is taken for granted by acting as though it has a shorter path to any requests it gets. Nodes typically start the discovery phase to find a route to the end node of interest. Whenever a node receives a request from a source node, it checks to see if it has a new route to the destination node. As soon as the broadcaster requests this information, the black hole node responds by saying that it has the most recent and shortest route to the destination node. The source node accepts the response as fact since there is no way to determine if the request was sent by a regular node or a black hole node. To ensure that packets are sent to their intended destination, source servers begin sending them to the black hole node, which subsequently begins dropping the packets they received. Based on the number of attacker nodes, black hole attacks may be divided into single and cooperative attacks. A single attacker node is involved in a single black hole assault, as opposed to a

cooperative black hole attack, which involves many attacker nodes cooperating to undermine network stability [3].

In addition to denial-of-service (DoS) attacks, which consume the most energy, the lack of an infrastructure exposes MANETs to a wide range of other threats [4–6]. Premature convergence increases the algorithm's capacity to discover the best value for the local minimum. Premature divergence can be ignored because it deems significant mutations to be normal, resulting in greater genetic variety among children. There was a significant improvement in energy efficiency and a consequent extension of network lifetime using QB's proposed algorithm over GA. The goal is to find a dominant collection of nodes by combining the weight matrices of table-driven and on-demand routing. Using the node's relative degree and the link expiration time, the LMANET was interconnected. We measured delay, total cluster head rounds, cluster head duration, overhead, and PDR to arrive at our conclusions. The proposed HCAL protocol outperforms in terms of performance. Clustering algorithms such as dynamic link duration, signal characteristic-based, dynamic Doppler velocity, and mobility-based algorithms are compared with each other. There is a well-defined organizational structure in place for these pieces, and it serves to emphasize their value by bringing attention to what was omitted and by posing important concerns that need additional investigation. After a thorough examination, specific observations are collected in order to assist in determining which risk reduction techniques are most suitable for a particular environment and then to communicate those strategies with the relevant parties [7].

Problem Statement: MANET security is critical in order to prevent many forms of attacks. An attack known as a "black hole" aims to break up all network connections and is one of the most widely used methods of doing so. In the event that two network nodes need to interact, the AODV routing protocol strives to find the shortest possible path between them. This attack cannot be detected or prevented by the AODV protocol because it does not include an algorithm for that. This research presents the method for identifying and differentiating between single and collaborative black hole attacks.

Contribution of the work is as follows:

- (a) Taking care of low latency while maintaining high throughput is the contribution of this study.
- (b) Above both are planned to achieve using new algorithm, which is called as multipath technique to overcome the black hole attack in mobile ad hoc (MTBD).
- (c) The paper suggests a pseudo-code algorithm that is distributed randomly for energy-efficient time synchronization in two-way packet delivery scenarios, where the clock offset and the propagation delay are factors to consider when sending the packet beacon message to the destination vehicles.

The paper is organized as follows. Section 2 discusses related work. Section 3 introduces the existing mobile ad hoc network model and shows the role of the network identity. Section 4 presents the algorithms for formation/joining a

network and how split and merge are managed. Sections 5 and 6 show the experimental setup and experimental results, respectively, and, finally, Section 6 concludes the paper.

2. Related Work

2.1. Black Hole Attack. DoS is a kind of black hole attack that is considered as one of the more attractive attacks. In MANETs, it is also referred as a full average packet attack. With changeable protocols and free communications in MANETs, a black hole component can easily and quietly move inside the network. Route discovery is the exact situation which is suitable for black hole creations. There is no valid path from the originating point to the destination at first. For route discovery, the source node sends a RREQ packet to the works by interfering. When a real sender moves an RREQ packet from a sender, it transfers it to the next node in the chain if it is not a cluster head; however, whenever a black hole node receives an RREQ, it transfers a fraudulent route reply with a high timestamp in order which is going to win the route request. The hash function is being utilized in assessing where frequently the route is updated, or how fresh it is. The black hole node manipulates the base station into thinking it has a legal, short, and refreshing route toward destination when it actually does not. The black hole node delivers a signal to the intermediate host and joins the program's route between both the initial point and the final node in this approach. The source node begins transmitting packets of data to the black hole nodes after the path has been created, and the black hole node gradually destroys all data packets before passing them on to the destination's node [8, 9]. Figure 2 shows black hole attack.

Each node in a MANET maintains a routing table, and each routing table maintains a sequence number, which is used to keep current routing information. The source node sends data packets to the destination node via neighbor nodes, which contain sequence numbers that are used to determine the proper path connection to the link. More update information equals a higher sequence number. The value of the sequence number is 216-1. It wraps around after the end of the sequence number value and returns to the original value. In a mobile ad hoc network, black hole nodes are mobile nodes that present more updated information by displaying a higher sequence number value (a higher sequence number indicates more updated information, whereas a lower sequence number indicates less updated information in the routing table). Because the sequence number of the black hole node is higher than the current flack sequence number, the node maintains its course through the black hole node. Neighbor nodes send data packets through the black hole, which the black hole node drops.

The method's strength comes in its ability to pinpoint optimal values for such variables as detection probability and throughput. This approach aids in both the detection and prevention of black hole attacks in MANET [10]. When malicious nodes misinterpret routing for dissemination, only the least diverted packets eventually make it to the target hub, and a route layer vulnerability known as a black hole assault is launched. Through simulations, [11]

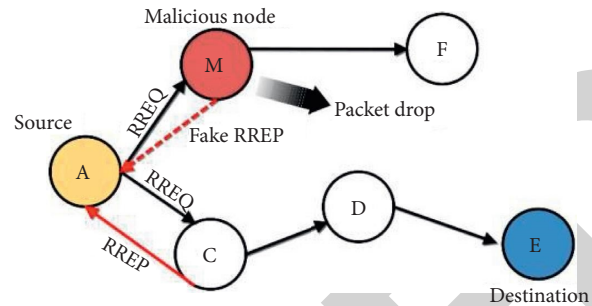


FIGURE 2: Black hole attack.

demonstrated that an NHBADI approach for identifying attackers in MANET reduced network inefficiency, PDR, and the normalized routing cost. Not only was the attack discovered, but the suggested method also isolated vulnerable nodes for black holes in the MANET. Proximity set method was developed by [12] to identify malicious nodes in MANET (PSM). Simulation findings show that the proposed AODV with PSM is superior to the current ad hoc on request distance vector direction methodology for discovering black holes. However, the E2E delay was subpar. The IDS method was proposed for black hole detection in [13]. Selecting the node with the greatest sequence number leads to improved QoS and, following analysis, a 60% boost in PDR. One potential drawback is that it is not very effective against intrusion attempts.

The benefit point of this approach is that a comparative approach for the protocols is helpful for the determination of black holes. IoT is a critical constituent of the industrial revolution 4.0, and its operation necessitates intensive study to guarantee that it functions properly [14]. AODV, DSR DSDV, reverse-AODV (RAODV), AOMDV, and temporally order routing algorithm (TORA) are some of the MANET protocols [14]. Packet networks are a type of packet network. Because of its mobility, it is a wireless system with a self-motivated topology [15]. Furthermore, with no permanent infrastructure, each node is operating as a bridge, source, or a destination in order to pass data packets to nodes outside the transmission range [16, 17]. This approach uses a digital signature-based IDS for identification of attacks on black holes.

3. Existing Work

3.1. FIDS. Handout of this approach lies in the smooth detection of black holes. It uses NS-2 simulators for better results. This approach is shown to be efficient than the normal AODV protocols. For AODV, [18] developed a mechanism for detecting black holes. Reference [19] presented a fuzzy-based genetic algorithm that uses beginning rules depending on fuzzy algorithm and final rules depending on GA. Reference [20] suggested a TCP/IP network based on genetic-based IDS. Reference [21] investigated RREQ flooding attacks and devised a new strategy based on next node monitoring to counter RREQ flooding attacks. Pitfall lies with its limitation of working with only one kind of attack along with low jitter values.

3.2. *GABFO*. Beneficence of this approach is that one can make a clear black hole attack analysis. This approach uses GA with a combination of BFO using which the black hole attacks are defended. The obstacle for this approach is that it is limited to few protocols and does not work in AODV protocol. MANETs are defined by their lack of housing, dynamical topology, and usage of the open wireless medium [22]. A black hole assault poses a significant threat to such networks. There are two purposes to this study. To begin, we will go through a comprehensive list of known black hole countermeasure methods. Reference [23] suggested a method for analyzing AODV's vulnerability to assaults, particularly the most prevalent network layer hazard, the black hole attack, and developing a conditional-based IDS using the GA method. The suggested arrangement uses a GA to assess each node's behavior and provide information about the attack. GAC is a collection of rules based on AODV's key features, such as request forwarding rate and reply receive rate.

3.3. *NSABO*. High packet delivery with minimum packet loss is one of the features of the proposed method. A proposed framework with the help of a simulator NS-2 works. Reference [24] presented a dynamic training method for anomaly detection where the supervised learning is restructured at regular intervals of time. Reference [25] proposed a technique in which the source verifies the reply a packet arriving from various nearby nodes, and then waits and checks the responses from all cluster heads to choose the finest and most protected route. The highlight of this approach lies in the detection of a secured receiver and senders' path; the pitfall of this approach is that it is limited to a few and general attacks. Reference [26] presented a system in which network nodes are divided into two categories: trustworthy nodes and regular nodes. Trusted nodes are nodes that are present in the network when it is created. Ordinary nodes are nodes which join the network at a later time. Ordinary nodes must demonstrate their reliability to be designated as trusted nodes.

3.4. *SAODV*. The plus point of this approach is that it is helpful in the discovery of black as well as gray hole attacks. Numerous DoS attacks have been launched. The black hole attack is the one where the attacker announces that it has the best path to the node whose packets it intends to discard or intercept using the routing protocol [27]. RREQ packets are broadcasted, whereas destination network receives data packets sent from source nodes which shows the black hole attack working nature. The black hole cluster with a higher sequence number and fewer hop counts, on the other hand, delivers RREP to the originating node right away [28]. This approach is helpful for the detection and prevention of malicious selfish nodes. The downfall of this approach is that it is limited to work with only one kind of protocol.

3.5. *TBBTD*. Contribution lies in isolating the detected black hole nodes. A timer-based baited technique is used. MANET practices a wireless link to attach nodes; therefore,

throughput is considered a significant network feature. Wireless links have a substantially lower bandwidth than conventional lines. The signal of a wireless link can be harmed by noise, interfering from that other source, or fading [2]. According to [29], AODV has superior performance features than additional routing protocols underneath various performance statistics; The AODV protocol is superior to other routing protocols because it combines the principles of mutually DSR and DSDV and reaps both benefits [30]. They devised a method based on the CBDS. The three steps of CBDS' black hole detection are bait, counter trace, and responsive defense. During the bait stage, the source node chooses one out of its neighbors at random and submits a bait request with that node's id. The RREP of the bait RREQ is used to construct a group of suspicious nodes in the reverse trace phase, after which the neighbor nodes translate to unrestrained mode to identify the presence of an assailant node within the path. A black hole alarm is broadcast to neighbor nodes for a piece black hole node found in the specific network. In reference [31], the proposed method relies on a specific type of node known as guard nodes, which aid in the detection of network black hole nodes. Guard nodes are promiscuous nodes that keep an eye on the activity of other devices in the system. The activity of the devices in the network is recorded in tables on guard nodes. Each network has a link quality that is calculated based on its network activity, and it drops because here the node is only the one which transmits no RREQ but only RREP. Few systems advanced to employ a trust-built methodology, in which apiece network device has trustworthiness that is established by the node's behavior. If the node's value is too less, it is classified as a node with black hole nature, as described in [32]. The disadvantage of this strategy is that the obtained parameter values are low and must be improved. The comparisons of existing methods are given in Table 1.

In [40], the authors suggested a trust-based multipath routing protocol called TBSMR to boost the MANET's overall performance. The key feature of the suggested protocol is that it incorporates numerous elements such as packet loss reduction, congestion management, secure data transfer, and malicious node identification to improve the MANET's QoS. The effectiveness of the suggested protocol is examined by the simulator in NS-2. Ensemble models based on machine learning were constructed [41]. While all of the attacks were labeled as anomalies and regular traffic, binary and multiclass classifications were performed on the KDD99 and NSLKDD datasets. Class designations included the five most common types of attacks: DoS probe, user-to-root, root-to-local, and normal. To predict the amount of vehicle crashes in a heavily trafficked challenging zone, researchers employ an artificial spider-monkey approach to probe sybil assault techniques on VANETs [42].

4. Proposed Approach

An MTBD algorithm is supposed to be transmitted to all CHs to tackle the sinkhole problem. However, before going into detail about the method, a variant of the routing protocols is provided to ensure disjoint routes: to ensure

TABLE 1: The comparison of existing methods.

Author	Contribution	Methodology	Advantage	Limitations
CBHDAP Vijayakumar and Somasundaram [33]	Sleuthing and circumventing black hole attacks in MANET	CBHDAP	Optimum results for throughput and detection probability	Does not work for security attacks
DSIDS Talukdar et al. [34]	BHAODV and DBHAODV protocols	IDS and digital signature	QoS, PDR, overhead is detected	Works well with a limited number of packets and nodes
FIDS Balan et al. [35]	Black hole node detection	NS-2 simulator	This approach is efficient than the normal AODV protocol	Limited to only one kind of attack, low jitter values
GABFO KanikaBawa [36]	Analysis of black hole attack	GA, BFO	Black hole attack effects are detected	Does not work with AODV protocols
NSABO Jaisankar et al. [37]	Finding a safe path between receiver and sender	Proposed framework with the NS-2 simulator	High packet delivery with less packet loss	Limited to two attacks
SAODV Dhende et al. [38]	Black, gray hole attack removal	SAODV, NS-2	Detection and prevention of malicious and selfish nodes	Works with only one protocol
TBTD Yasin and Abu Zant [39]	Detection and isolation of black hole node	Timer-based baited technique	Throughput, PDR, and end-to-end delay are obtained	Throughput, PDR, and end-to-end delay need to be enhanced

discontinuous control message paths, AODV is changed as follows: after the source broadcasts the RREQ, each intermediary node that receives it adds its location to the requests and broadcasts it to its neighbors again. Until the author utilized the sink node, this procedure is repeated. As a response to the source node's request to deliver data over the selected paths, the sink node creates discontinuous paths.

The following is a description of the suggested attack recognition and protection system, MTBD:

Phase 1: the network is organized into clusters, with a CH for each cluster.

Phase 2: when the data Msg is available, the CH creates an RREQ as a cluster head. In the new version of the AODV protocol, the reply Msg comprises two distinct pathways to the sink node, as previously indicated. The CH transmits the data message over one of the receiving routes and generates the Ctrl message on the other. The sender ID, size, controlling route information, established written route, and checksum are all included in the Ctrl message.

Phase 3: after receiving the transmitted signal and both are said, the sink node begins comparing the control message to the received message. The sink node will determine if the highly considered has been altered or if it has not been changed by evaluating the control messages. Furthermore, if the sinkhole discards multiple emails, the sink node will notice when it receives control messages.

Phase 4: the sink node analyzes the histories of the same route to determine which CH is targeting the traffic because it records all of the routes.

Phase 5: if the sink node senses an incursion, it sends out an alarm to all of the CHs, warning them to stay away from the compromised one.

In Algorithm 1, there are supposed to be S nodes, a subset of a cluster head H, and one or more sink nodes SN. When a sensor sends the RREQ message to the CH_j attached to it, it is prepared to submit its sensed data. Neighbor CH_j transmits a message to its neighbors using the approach described in step 2 above. It sends an RREP message to s_i with an address to send after receiving the two disjoint pathways. CH_j receives the message and sends the received message (data Msg) over one of the routes it received—send (Msg)—while also forming a Ctrl message to send through the other route send (Ctrl). Both data and control messages arrive at the sink node via distinct paths. The sink verifies the data it receives to the information in the Ctrl message. The sender ID, message size, packet information path, and checksum are all compared. The established written route is double-checked to ensure that it has not been tampered with and that the routes are disjoint. If the description in the Ctrl message does not match the data, the route and its history are reviewed. When a large amount of messages are sent to the same CH, it is referred to as a sinkhole node. The detailed flowchart for the proposed method is shown in Figure 3.

Following IDS' disposal of status packets, all remaining nodes should receive them. A check should be done to determine whether packets have been dropped or not, and the right explanation for the dropped packets must be recognized. If a particular node drops whole packets, which is designated as a BH node, we must add it to the blacklist.

5. Experimental Setup

OPNET from Riverbed Technology is used to simulate the methods discussed in this work. OPNET supports state-of-the-art network simulation support with a huge stack of inbuilt network node types, protocols, and topologies. The

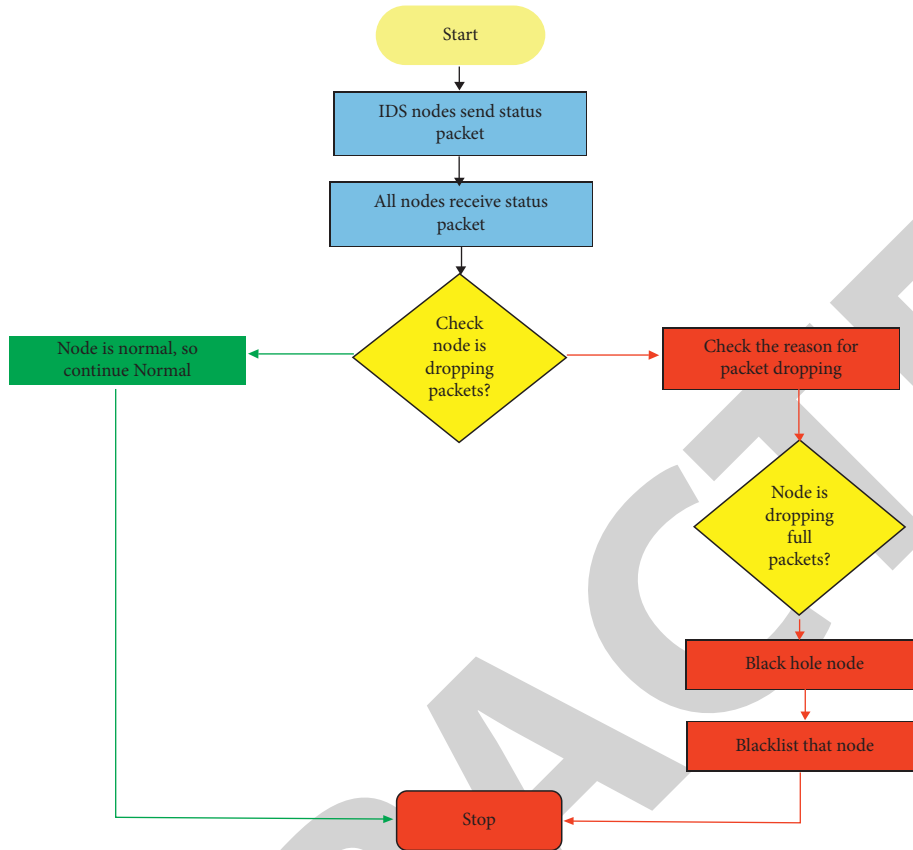


FIGURE 3: Flowchart for the proposed method.

```

 $s_1, s_2, s_3, \dots, s_n \in S$ 
 $sn_1, sn_2, sn_3, \dots, sn_n \in SN$ 
 $CH_1, CH_2, CH_3, \dots, CH_1 \in H$ 
Repeat
  if ( $CH_j$  ready to send)
    sending devices  $\xrightarrow{R} REQ$  Cluster Headj
    ClusterHeadj  $\xrightarrow{R} REQ$  Neighbour (Cluster Headj)
    Cluster Headj  $\xleftarrow{RREQ}$  Neighbour (Cluster Headj)
     $S_i \xrightarrow{\text{Pass information (Data)}}$  Cluster Headj
    Send (message)
    Send (control)
  End if
 $\forall sn_i \in SN$ 
  Receive (Message (information))
  Receive (Message (Control))
  if ((compare (message (information), Message (control)) = true)
    Alert
  End if
Until the transmission process is completed
End
  
```

ALGORITHM 1: Proposed MTBD algorithm.

freedom to design any kind of protocols and network architecture is provided by the scripting provision and graphical interface of OPNET. OPNET allows user to script user-defined network components, protocols, and

architectures using C++. Visual Studio IDE is used to develop a dedicated user interface to load the input scripts to OPNET and to present results received from OPNET. Table 2 shows simulations parameters considered for study.

TABLE 2: Simulation parameters.

S. no.	Entity	Details
1	Frequency band	Mixed mode 2G, 3G, 4G, and VoLTE
2	RF range	Based on the type of 100 to 1000 meters
3	Network density	Typical real world
4	No. of nodes	100 to 1000 in steps of 100
5	No. of routers	Automatic selection
6	Node placement	Random distribution
7	Node types	Typical MANET nodes
8	Simulation area	10000 sq. meters
9	Simulation time	168 real-world hours

TABLE 3: Throughput.

Parameter: throughput (kbps)							
Nodes	FIDS [34]	CBHDAP [32]	GABFO [35]	DSIDS [33]	TBBTBD [38]	NSABO [36]	MTBD [proposed method]
100	1200235	3498826	3996522	3149617	3660561	999622	3800366
200	1199316	3473081	3932599	3110567	3634051	974376	3792175
300	1198934	3441395	3859589	3068492	3606896	944088	3782606
400	1197893	3406603	3774152	3017808	3572176	908121	3769580
500	1197117	3366522	3678542	2962879	3534194	868428	3756476
600	1192534	3324746	3570724	2899399	3491403	821793	3742181
700	1192253	3274350	3451660	2826766	3446190	774666	3726018
800	1188402	3220755	3321135	2750391	3393795	719839	3708827
900	1185600	3161586	3178877	2669088	3339483	662409	3691235
1000	1181402	3096771	3024765	2577946	3280624	596816	3670213

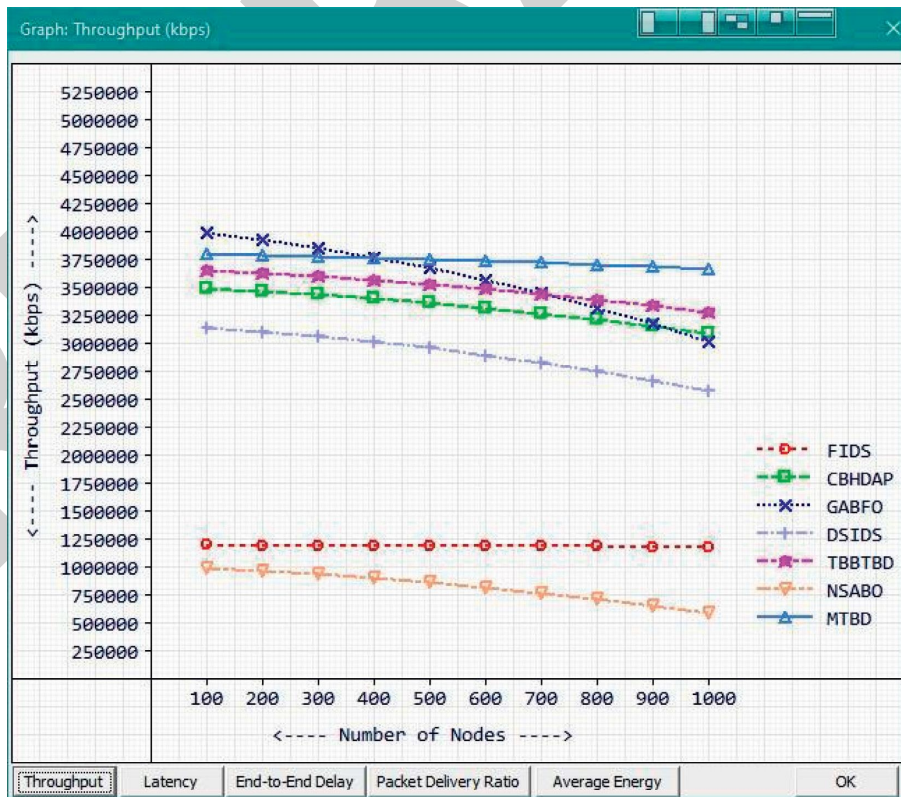


FIGURE 4: Throughput graph for various methods.

TABLE 4: Latency.

Nodes	Parameter: latency (ms)						
	FIDS [34]	CBHDAP [32]	GABFO [35]	DSIDS [33]	TBBTBD [38]	NSABO [36]	MTBD [proposed method]
100	250	222	171	230	220	202	190
200	250	221	178	233	221	205	194
300	252	223	186	235	223	205	196
400	253	225	193	234	222	207	196
500	253	223	199	236	223	209	196
600	254	224	209	238	226	213	201
700	254	227	216	237	226	213	202
800	257	225	221	241	227	217	201
900	255	227	231	240	226	219	203
1000	259	228	238	243	227	219	205

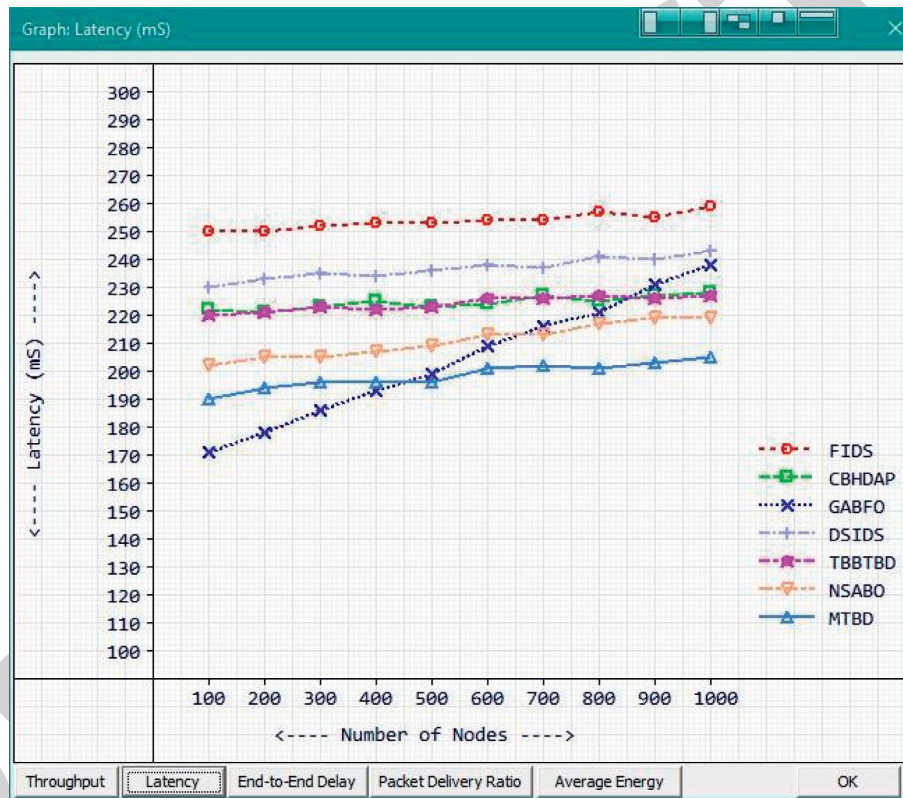


FIGURE 5: Latency.

6. Experiment Results

To show the importance of proposed method, the following parameters were considered as throughput, latency, packet delivery ratio, and average energy.

Throughput: the pace of data flow for a specific communication channel is referred to as throughput. During environmental monitoring, throughput is a critical aspect that necessitates constant data collecting. The higher the throughput quality, the greater the value of the network in question. The observed throughput values obtained from the regression results are presented in Table 3. The throughputs of different networks are shown in Figure 4.

Latency: it is a measure of reaction time; a shorter response time indicates better network quality. The latency numbers produced concerning different times for comparing techniques with simulation results are shown in Table 4 and Figure 5. Network performance is inversely proportional to latency. Milliseconds are used to measure it (ms).

End-to-End Delay: it is the sum of all latency issues, such as jitter, system postponement, and IP delay. It is taken into account how long it takes a data packet to move from source to destination. The worse the network traffic, the shorter the packet delay time. By established approach, Table 5 illustrates several end-to-end delay times. The end-to-end delays of different networks are shown in Table 5 and Figure 6.

TABLE 5: End-to-end delay.

Nodes	Parameter: E2ED (ms)						
	FIDS [34]	CBHDAP [32]	GABFO [35]	DSIDS [33]	TBBTBD [38]	NSABO [36]	MTBD [proposed method]
100	418	378	326	391	338	283	258
200	418	380	338	400	342	280	265
300	424	384	339	399	346	284	259
400	429	386	356	397	353	290	265
500	433	389	360	400	352	294	265
600	434	399	373	402	357	300	264
700	439	394	379	407	357	297	271
800	437	404	386	413	368	301	270
900	438	407	398	410	371	306	274
1000	442	408	406	417	373	304	276

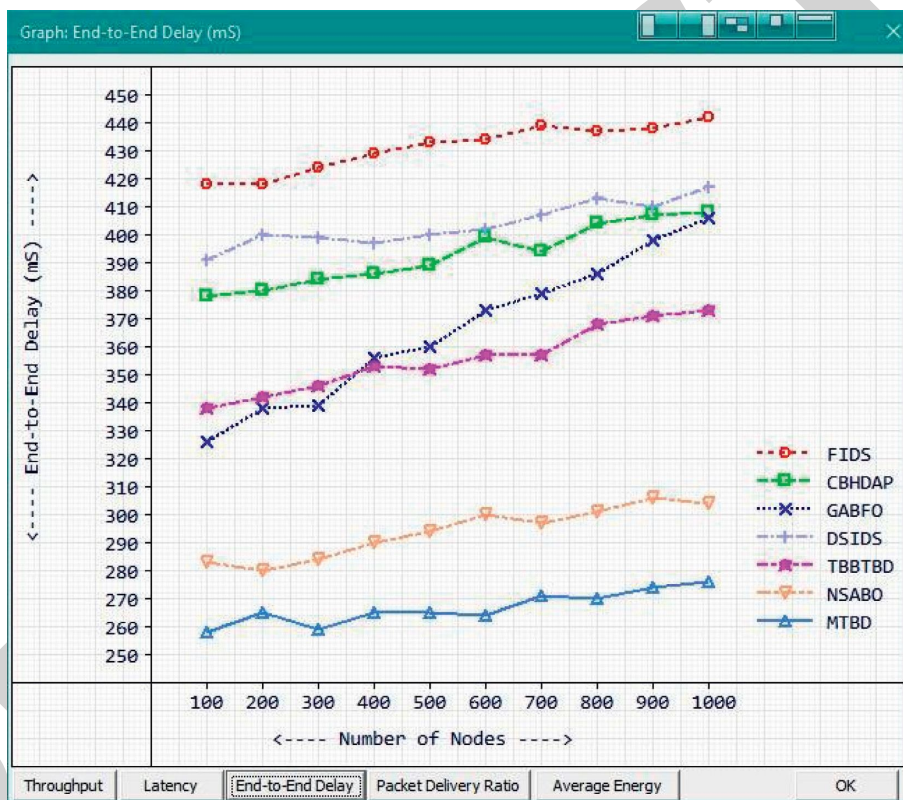


FIGURE 6: End-to-end delay graph.

TABLE 6: Packet delivery ratio.

Nodes	Parameter: PDR (%)						
	FIDS [34]	CBHDAP [32]	GABFO [35]	DSIDS [33]	TBBTBD [38]	NSABO [36]	MTBD [proposed method]
100	90	94	90	90	95	87	98
200	89	93	90	88	94	85	96
300	89	92	89	87	94	84	96
400	87	92	87	86	93	84	94
500	87	90	87	86	92	82	94
600	85	90	86	85	91	81	92
700	84	90	85	84	89	81	92
800	84	88	83	83	88	80	91
900	82	87	83	82	88	79	90
1000	82	86	82	81	87	78	89

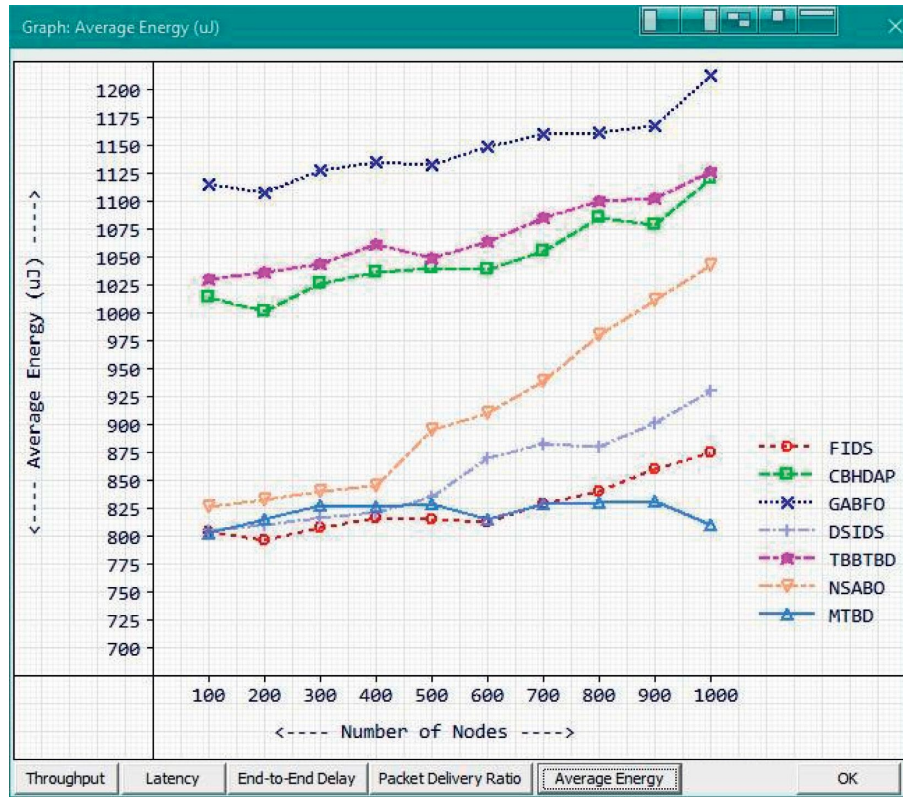


FIGURE 7: PDR.

TABLE 7: Average energy.

Parameter: avg. energy (μ)							
Nodes	FIDS [34]	CBHDAP [32]	GABFO [35]	DSIDS [33]	TBBTBD [38]	NSABO [36]	MTBD [proposed method]
100	804	1014	1116	806	1031	827	803
200	797	1002	1108	810	1037	833	815
300	808	1027	1128	817	1044	840	828
400	817	1037	1136	822	1062	845	827
500	816	1040	1133	835	1049	895	829
600	813	1039	1149	871	1064	910	815
700	829	1055	1160	883	1086	939	829
800	841	1086	1162	881	1101	981	830
900	860	1079	1168	902	1103	1012	832
1000	875	1120	1213	931	1127	1043	811

Packet Delivery Ratio (PDR): it is measured as the sum of the mass of packets sent from the sources to the number of packets received at the destination; larger values indicate less data loss, implying a network design with a robust

architecture. The packet delivery ratio values are presented in Table 6 and Figure 7.

Average Energy: it specifies how much energy the proposed method uses to get the outcomes in the

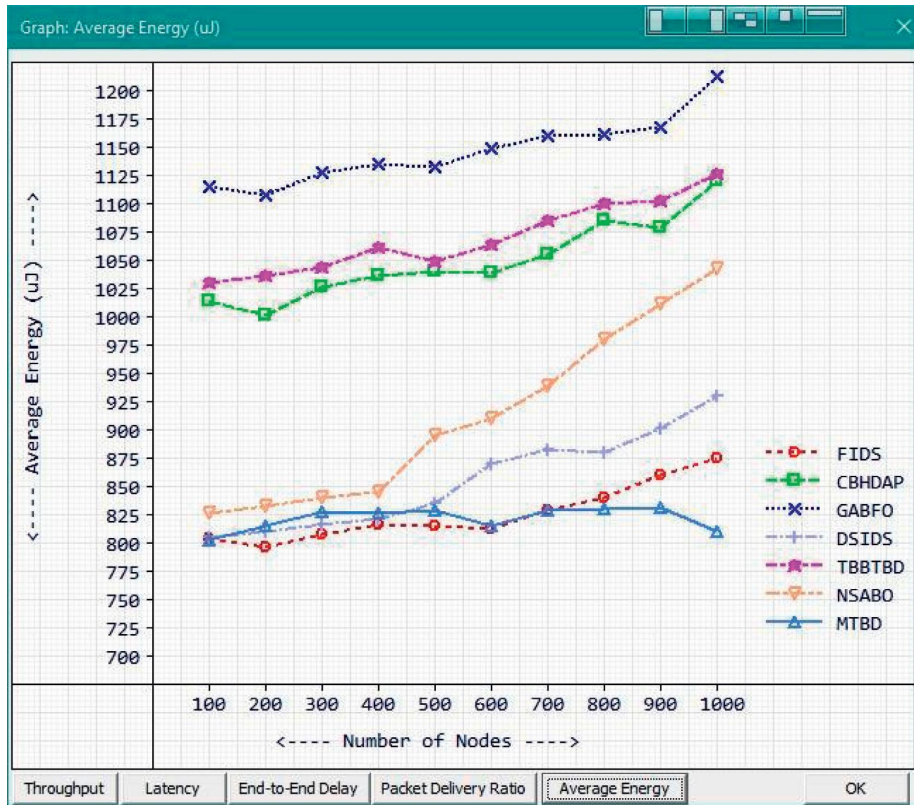


FIGURE 8: Average energy.

simulated environment. The system’s effectiveness will increase as the amount of energy spent decreases. The average energy values are presented in Table 7 and Figure 8.

7. Conclusion

The black hole attack is regarded as one of the most dangerous threats to MANET’s operations. Detecting and isolating any network black hole nodes is considered a critical task for preventing network collapse. We developed a smart black hole identification technique in this study, which should be taken into account while designing and emerging any black hole combat protocols or practices. Block-hole detection of the proposed method is improved. It is measured based on the parameters like throughput, end-to-end delay, latency, packet delivery ratio, and average energy. The proposed MTBT incorporates both timers and baiting approaches. The obtained average values of all the considered parameters are throughput (3743967.7 kbs), end-to-end delay (266.7 ms), latency (198.4 ms), packet delivery ratio (93.2%), and average energy (821.9 μ J). The suggested technique’s simulation results show that the end-to-end delay, throughput, PDR, and average energy are far better than existing state-of-the-art approaches. In the future, we intend to develop the proposed model to enhance throughput and packet delivery ratio while reducing end-to-end delay and average energy consumption.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding the publication.

References

- [1] S. Mirza and S. Z. Bakshi, “Introduction to MANET,” *International Research Journal of Engineering and Technology*, vol. 5, no. 1, pp. 17–20, 2018.
- [2] V. Goyal and G. Arora, “Review paper on security issues in mobile Adhoc networks,” *International Research Journal of Advanced Engineering and Science*, vol. 2, no. 1, pp. 203–207, 2017.
- [3] X. Lai, J. Xia, L. Fan, T. Q. Duong, and A. Nallanathan, “Outdated Access Point Selection for Mobile Edge Computing with Cochannel Interference,” *IEEE Transactions on Vehicular Technology*, vol. 71, pp. 7445–7455, 2022.
- [4] J. Lu, L. Chen, J. Xia et al., “Analytical offloading design for mobile edge computing-based smart internet of vehicle,” *EURASIP Journal on Applied Signal Processing*, vol. 2022, no. 1, 44 pages, 2022.
- [5] L. Zhang, W. Zhou, J. Xia et al., “DQN-based mobile edge computing for smart Internet of vehicle,” *EURASIP Journal on Applied Signal Processing*, vol. 45, no. 1, 2022.

- [6] L. Chen, R. Zhao, K. He, Z. Zhao, and L. Fan, "Intelligent Ubiquitous Computing for Future UAV-Enabled MEC Network Systems," *Cluster Comput*, vol. 25, pp. 2417–2427, 2021.
- [7] S. Singh, A. Bhasin, and A. Kalia, "Capitulation of mitigation techniques of packet drop attacks in MANET to foreground nuances and ascertain trends," *International Journal of Communication Systems*, vol. 34, no. 10, Article ID e4822, 2021.
- [8] D. Singh and A. Singh, "Enhanced secure trusted AODV (ESTA) protocol to mitigate blackhole attack in MobileAdHoc networks," *Future Internet*, vol. 7, no. 3, pp. 342–362.
- [9] P. R. Dumne and A. Manjaramkar, "Cooperative bait detection scheme to prevent collaborative blackhole or grayhole attacks by malicious nodes in MANETs," in *Proceedings of the 2016 5th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO)*, pp. 486–490, Noida, India, September 2016.
- [10] K. Vijaya Kumar and K. Somasundaram, "Study on reliable and secure routing protocols on manet," *Indian Journal of Science and Technology*, vol. 9, no. 14, pp. 1–10, 2016.
- [11] M. Rajesh Babu and G. Usha, "A novel honeypot based detection and isolation approach (NHBADI) to detect and isolate black hole attacks in MANET," *Wireless Personal Communications*, vol. 90, no. 2, pp. 831–845, 2016.
- [12] K. Vijaya Kumar and K. Somasundaram, "Detection of black hole attacks in MANETs by using proximity set method," *International Journal of Computer Science and Information Security*, vol. 14, no. 3, pp. 136–145, 2016.
- [13] S. K. Arora, S. Vijan, and G. S. Gaba, "Detection and analysis of black hole attack using IDS," *Indian Journal of Science and Technology*, vol. 9, no. 20, pp. 1–5, 2016.
- [14] M. Z. Ibrahim and R. Hassan, "The implementation of Internet of Things using testbed in the UKMnet environment," *Asia-Pacific Journal of Information Technology & Multimedia*, vol. 08, no. 02, pp. 1–17, 2019.
- [15] T. Salam and M. S. Hossen, "Performance analysis on homogeneous LEACH and EAMMH protocols in wireless sensor network," *Wireless Personal Communications*, vol. 113, no. 1, pp. 189–222, 2020.
- [16] T. Salam and M. S. Hossen, "Performance analysis on homogeneous LEACH and EAMMH protocols in wireless sensor network," *Wireless Personal Communications*, vol. 113, no. 1, pp. 189–222, 2020.
- [17] M. Singh, C. Kumar, and P. Nath, "Challenges and protocols for P2P applications in multi-hop wireless networks," in *Proceedings of the 2018 Second International Conference on Computing Methodologies and Communication (ICCMC)*, pp. 310–316, IEEE, February 2018.
- [18] S. Kurosawa and A. Jamalipour, "Detecting blackhole attack on AODV-based mobile ad hoc networks by dynamic learning method," *International Journal on Network Security*, vol. 5, 2007.
- [19] Yu Wang, "Using Fuzzy Expert System Based on Genetic Algorithm for Intrusion Detection System," in *Proceedings of the 2009 International Forum on Information Technology and Applications*, Chengdu, China, April 2009.
- [20] G. Xiaopeng and C. Wei, "A novel gray hole attack detection scheme for mobile ad hoc networks," in *Proceedings of IFIP International Conference on Network & Parallel Computing*, Dalian, China, September 2007.
- [21] Y. Hu, Y. Perrig, and B. Johnson, "Rushing attack and defences in wireless Ad hoc networks routing protocols," in *Proceeding of the 2nd ACM workshop on Wireless Security*, New York, NY, USA, 2003.
- [22] S. Ahmed and M.E. A. Shoukry, "A novel taxonomy of black-hole attack detection techniques in mobile ad-hoc network (MANET)," in *Proceedings of the 2013 IEEE 16th International Conference on Computational Science and Engineering*, pp. 346–352, IEEE, Sydney, Australia, December 2013.
- [23] S. Sujatha, V. Dharmar, and R. S. Bhuvaneswaran, "Design of genetic algorithm-based IDS for MANET," in *Proceedings of the 2012 International Conference on Recent Trends in Information Technology*, pp. 28–33, IEEE, Chennai, India, April 2012.
- [24] S. Kurosawa, H. Nakayama, N. Kato, A. Jamalipour, and Y. Nemoto, "Detecting blackhole attack on AODV-based mobile ad hoc networks by dynamic learning method," *International Journal on Network Security*, vol. 5, no. 3, pp. 338–346, 2007.
- [25] V. Sankaranarayanan and L. Tamilselvan, "Prevention of blackhole attack in MANET," in *Proceedings of the 2nd International Conference on Wireless Broadband and Ultra Wideband Communications*, IEEE, 2007.
- [26] A. Tcha and A. Mishra, "Collaborative security architecture for black hole attack prevention in mobile Ad Hoc networks," in *Proceedings of the Radio and Wireless Conference: AWCON'03 Proceedings*, IEEE, Boston, MA, USA, August 2003.
- [27] V. Mohan, "Pawar and J. Anuradha, "Network security and types of attacks in network," *Procedia Computer Science*, vol. 48, pp. 503–506, 2015.
- [28] SapnaGambhir and S. Sharma, "PPN: prime product number based malicious node detection scheme for MANETs," in *Proceedings of the 3rd International Advance Computing Conference (IACC)*, IEEE, 2013.
- [29] A. K. S. Ali and U. V. Kulkarni, "Comparing and analyzing reactive routing protocols (aodv, dsr and tora) in QoS of manet," *IACC*, in *Proceedings of the 7th IEEE International Advanced Computing Conference*, pp. 345–348, Hyderabad, India, 2017.
- [30] M. Sathya and M. Priyadarshini, "Detection and removal of black hole attack in mobile ad-hoc networks using cooperative bait detection method scheme," *International Journal of Scientific & Engineering Research*, vol. 7, no. 3, pp. 81–85, 2016.
- [31] A. R. Rajeswari, K. Kulothungan, and A. Kannan, "GNBAODV: guard node based –aodv to mitigate black hole attack in MANET," *International Journal of Scientific Research in Science, Engineering and Technology*, vol. 2, no. 6, pp. 671–677, 2016.
- [32] A. Jain, U. Prajapati, and P. Chouhan, "Trust based mechanism with AODV protocol for prevention of black-hole attack in MANET scenario," in *Proceedings of the 2016 Symposium on Colossal Data Analysis and Networking*, CDAN 2016, Indore, India, March 2016.
- [33] K. Vijayakumar and K. Somasundaram, "An effective CBHDAP protocol for black hole attack detection in manet," *Indian Journal of Science and Technology*, vol. 9, no. 36, 2016.
- [34] M. I. Talukdar, R. Hassan, M. S. Hossen, K. Ahmad, F. Qamar, and A. S. Ahmed, "Performance improvements of AODV by black hole attack detection using IDS and digital signature," *Wireless Communications and Mobile Computing*, vol. 2021, Article ID 6693316, 13 pages, 2021.
- [35] E. V. Balan, M. K. Priyan, C. Gokulnath, and G. U. Devi, "Fuzzy based intrusion detection systems in MANET," *Procedia Computer Science*, vol. 50, pp. 109–114, 2015.

Retraction

Retracted: Artificial Intelligence-Based Online Education System for University Music

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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] Y. Xie, "Artificial Intelligence-Based Online Education System for University Music," *Security and Communication Networks*, vol. 2022, Article ID 5842900, 13 pages, 2022.

Research Article

Artificial Intelligence-Based Online Education System for University Music

Yi Xie 

Hebei Institute of Communication College, Shijiazhuang 050000, China

Correspondence should be addressed to Yi Xie; xieyi@hebic.edu.cn

Received 23 June 2022; Revised 22 July 2022; Accepted 2 August 2022; Published 24 August 2022

Academic Editor: Tao Cui

Copyright © 2022 Yi Xie. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Aiming at the problems that students in the traditional music teaching system seldom participate in the system interaction and the relatively few types of system transportable files, this research designs and researches the music teaching system in school through artificial intelligence technology, streaming media technology, and webcast technology. The system mainly designs specific online classroom teaching modules according to the main characteristics of college music teaching. The system mainly adopts the b/s framework. Through the system performance test, the system response time is less than 2.5 when 200 people visit. Even when 500 people visit, the response time exceeds 3S, but it also maintains a certain performance level.

1. Introduction

In recent years, with the infiltration and development of quality education, generalist education, and other concepts, as well as the introduction of the spirit of the National Education Department on strengthening the public art education in colleges and universities, colleges and universities are paying more and more attention to the development of art education. Affected by this, the direction of music teaching management in some colleges and universities has also begun to change. Modern college music teaching management is gradually moving towards a more standardized and standardized direction. As for music teaching management, scientific and efficient teaching management systems are closely related to the improvement of teaching quality. How to use modern science and technology and network technology to serve the improvement of teaching quality in colleges and universities is an important issue in front of teaching innovation reform in colleges and universities [1, 2]. This research takes music online education as the object, with the help of the integration of artificial intelligence technology, and uses ant colony hybrid algorithm to build an intelligent composite system to serve the construction of music online education information system.

There are few special systems for music teaching in school, mainly comprehensive teaching systems. Therefore, there is no special system using music related technology. Information technology started early, and streaming media technology under the Internet environment has also developed rapidly. Many companies have started to develop many streaming media technologies for a long time. For example, a company applied streaming media technology to the Internet for the first time. Subsequently, they successively exited RealAudio, a media software system based on C/S architecture. A company further developed related technologies and launched RealPlayer series products. China's online education has begun to be applied to school teaching, but it is mainly aimed at Chinese and appreciation courses. Generally, audio tapes are simply played in music classes. With the continuous development of Internet technology, music has been able to spread through the network and has successfully achieved nondestructive quality. People also begin to use the Internet to appreciate music more and more. Under this background, there are more and more music training institutions. With the rapid development of Internet technology, many new online music education institutions are also slowly developing. Through the timeliness and locality of Internet technology, develop and build an online music education platform,

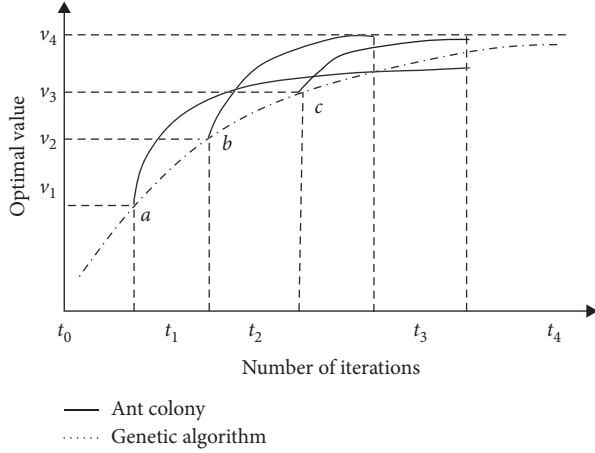


FIGURE 1: Optimal value iteration times curve.

provide learning resources, promote students' autonomous learning ability, and improve the quality of education to a certain extent [3, 4].

On the basis of this research, this paper proposes a research method for the online music education system in colleges and universities based on artificial intelligence. First, we design according to design principles and design requirements; secondly, we realize the connection between the main interface of the system and other interfaces through design. Then, the design of the system function is realized; finally, the design of the database is realized. Using streaming media and live broadcast technology, a set of online teaching system specially designed for music teaching is designed to realize the special functions of live broadcast classroom, performance appreciation, and so on. Through information technology, improving teaching quality and improving the overall teaching level is one of the steps of the corresponding information reform in contemporary times.

2. Intelligent Teaching System Based on Ant Colony Hybrid Genetic Algorithm

2.1. Algorithm Principle. The overall operation of genetic algorithm and ant colony algorithm in the whole optimization process is shown in Figure 1.

Because the hybrid algorithm combines the common characteristics of the two algorithms, it avoids the defects of the two algorithms to a great extent and gives full play to the advantages of the two algorithms in the process of solving the optimal solution. Using the Gaussian mutation method, all gene sequences are replaced by random numbers σ and μ normally distributed with the mean and variance of the corresponding mutation process. In the evolution strategy, it mainly includes two elements (X, σ) , where X represents the next access node and σ represents variance [5]. Its node descendant generation formula is as follows:

$$\begin{aligned} \sigma' &= \sigma eN(0, \Delta\sigma) \\ x' &= x + N(0, \Delta\sigma'). \end{aligned} \quad (1)$$

The mean value of $N(0, \Delta\sigma')$ is 0 and the variance is σ , which are independent and Gaussian random number vectors.

For ant colony algorithm, the calculation here refers to the method of solving TSP, and the specific process is shown in Figure 2.

2.2. Hybrid Algorithm Design and Process. The binary coding method is adopted in the algorithm implementation, and the codes of the same type of questions in the question bank are collected together. Suppose that the test paper requires m types of questions, each of which needs to contain $n_i, i = 1, 2, \dots, t$ questions. The corresponding code length is

$$\sum_{i=1}^m n_i. \quad (2)$$

The coding form is

$$b_{11}b_{12} \dots b_{1n}b_{21} \dots b_{2n} \dots b_{mn}, \quad (3)$$

where

$$b_{ij}, i = 1, 2, \dots, t, j = 1, 2, \dots, t, \quad (4)$$

n_i is for the questions in the examination question bank. The coding table is shown in Table 1.

During the design and implementation of hybrid algorithm, the same fitness function shall be used for genetic algorithm and ant colony algorithm, as follows:

$$F = \max f + \min f - f. \quad (5)$$

The evolution rate is the difference between the objective function of offspring and the average value of incidental objective function f . The selection operator adopts the offset roulette selection mode [6]. The crossover operator adopts the improved single point crossover method, and the mutation operator adopts the 0, 1 simultaneous mutation method. The flowchart of hybrid algorithm is shown in Figure 3.

In the hybrid algorithm, the evolution rate is defined as the absolute value of the difference between the average values of the parent and child populations. When the evolution rate of the parent and child is less than Q (set as a constant), it indicates that the genetic algorithm enters the invalid redundant iterative calculation stage after this time point and then enters the ant colony algorithm. That is,

$$|\overline{f_{fu}} - \overline{f_{zi}}| < Q. \quad (6)$$

The optimal solution of genetic algorithm is transformed into the pheromone of ACA. Suppose that the genetic algorithm obtains a group of optimal solutions with the number of m , and assume that the pheromone on the i -th test question in the test question bank at a certain time is

$$\tau_{ij}, j = 1, 2, \dots, t. \quad (7)$$

Then the initial pheromone settings are as follows:

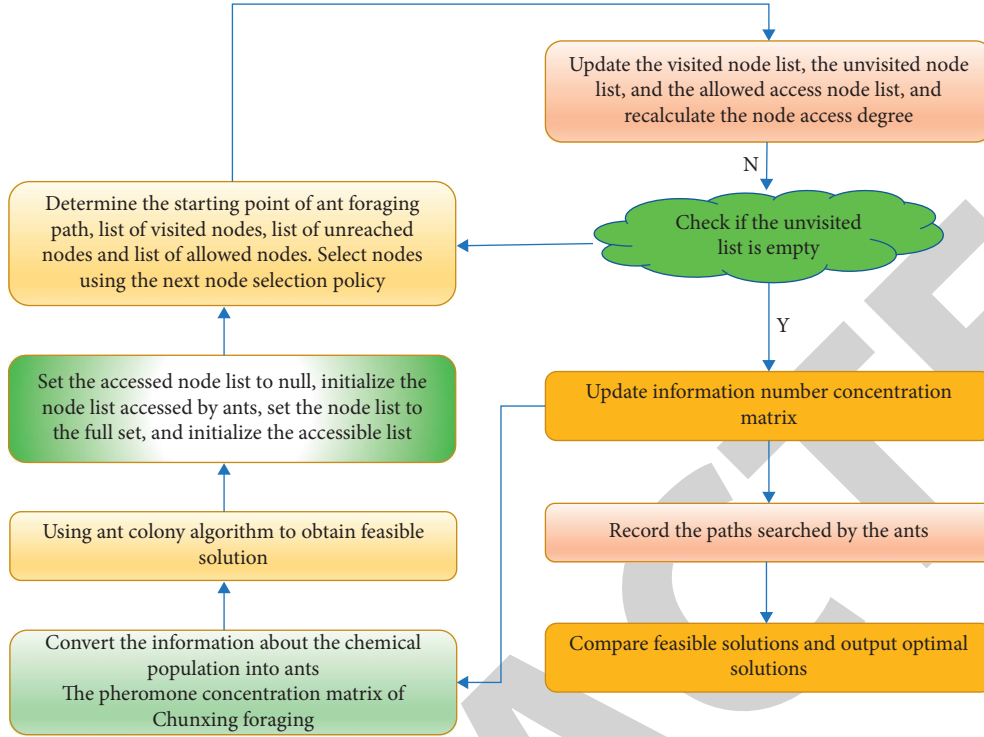


FIGURE 2: Algorithm mixing steps.

TABLE 1: Coding table.

b_{ij}	1	If b_{ij} is selected
	0	If b_{ij} is not selected

$$\tau_0 = 1 + \sum_{n=1}^m A_n, A_n = \begin{cases} \frac{1}{f_n} \\ 0 \end{cases} \quad A_n, A_n = \begin{cases} \frac{1}{f_n} \\ 0 \end{cases} \quad (8)$$

$$\tau_1 = 1 + \sum_{n=1}^m$$

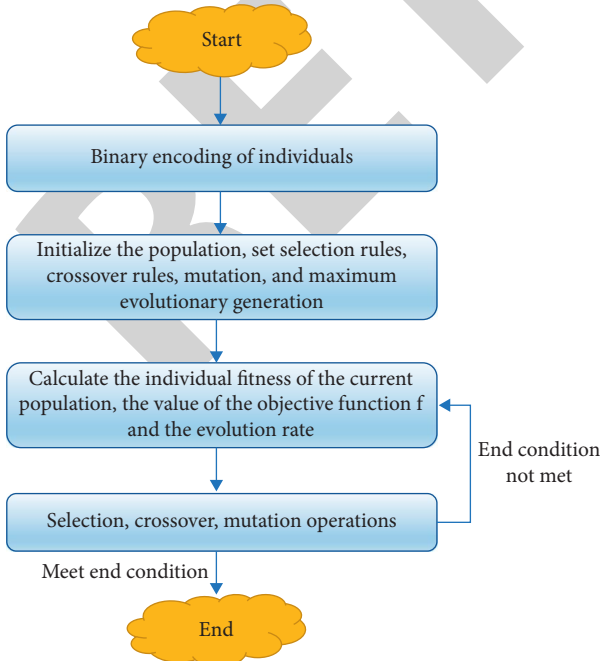


FIGURE 3: Flowchart of genetic algorithm in hybrid algorithm.

The pheromone updating method uses the max-min rule. In the traversal process of ant colony algorithm, pheromones are added only to the ant traversal path with the highest fitness. The relationship between the years of information concentration changes is expressed by introducing the binary (A, T) .

$$A = \{a_{11}a_{12}\dots a_{1n_1}a_{21}\dots a_{2n_2}\dots a_{mm}\}, \quad (9)$$

$$T = \{\Gamma(a_{ij}, c) | \Gamma(a_{ij}, c) \in R, i = 1, 2, \dots, m, j = 1, 2, \dots, n\},$$

where a_{ij} represents a test question. T is the set of pheromone trajectories, and c is 0 or 1. $\Gamma(a_{ij}, c)$ refers to the pheromone with or without test question a_{ij} selected. T can be expressed as a 13-dimensional matrix:

$$2 * \sum_{i=1}^m n_i \begin{bmatrix} \Gamma(a_{11}, 1) & \Gamma(a_{12}, 1) & \dots & \Gamma(a_{1n_1}, 1) & \dots & \Gamma(a_{mm}, 1) \\ \Gamma(a_{11}, 0) & \Gamma(a_{12}, 0) & \dots & \Gamma(a_{1n_1}, 0) & \dots & \Gamma(a_{mm}, 0) \end{bmatrix}_{2 * \sum_{i=1}^m n_i} \quad (10)$$

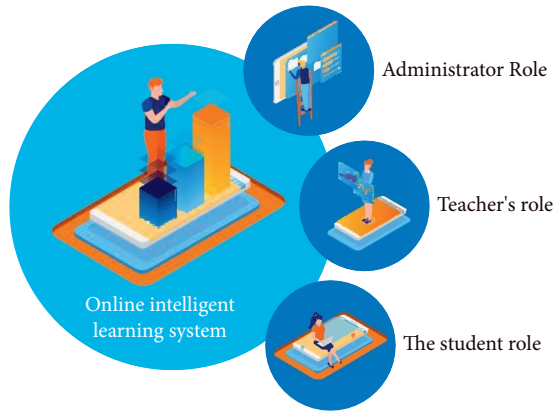


FIGURE 4: Schematic diagram of the online intelligent learning role module.

The search ability and convergence speed of the algorithm are closely related to the number of ants in the algorithm. The search ability of the algorithm is positively related to the robustness and the number of ants, while the convergence speed of the algorithm is negatively related to the number of ants. Due to this special situation, if there is no special requirement, the selection range of individual ants is [30, 60]. The path selection of the individual ant is based on the transition probability. When the signal is transmitted to the i of the ant, the individual ant determines the transition direction according to the transition probability p_{i0} or p_{i1} . The algorithm terminates when the chromosomes that meet the test paper generation requirements and the maximum number of iterations are reached [7–9].

3. Summary Design of the College Music Online Education System Based on Artificial Intelligence

3.1. System Function Module. The online intelligent learning system is mainly divided into three roles, administrator, teacher, and student. The example of role module is shown in Figure 4.

The main user role in the management of the online intelligent learning system is the administrator of the system, who has the right to add, delete, and modify specific basic information. The system adopts unified identity authentication. When users log in to the system with different identities, they can only see the functions corresponding to the identity. System management: The main task of this module is to maintain the normal operation of the college music education and teaching management system and important data security settings, including adding new users, modifying login passwords, and relogin. In addition, system management includes basic information management in education and teaching management, mainly including adding, modifying, deleting, and querying basic information such as departments, majors, etc., which is the basic module used by system administrators. The department, class, and data dictionary information of the college music education teaching management system are described.

The administrator role is divided into four submodules: teacher management, administrative class management, student management, and school course viewing. The example of the administrator submodule is shown in Figure 5.

The teacher's role is divided into four submodules: curriculum management, topic selection management, student learning module management, and personal basic information management. The example of the teacher submodule is shown in Figure 6.

The student role is divided into 4 submodules, including optional course viewing, my topic selection, my learning module, and personal basic information management. The example of the teacher submodule is shown in Figure 7.

3.2. System Flowchart. The sample flowchart of topic selection of students in the system is shown in Figure 8.

In this system, teachers first set up their own courses and edit the relevant materials of the courses, such as course overview, course setting cycle, corresponding chapters of the courses, courseware under the chapters, and standardized test questions. After editing, they choose to publish the courses. After the teacher publishes the course, students can log in to the system to query the course information available for selection and view the course overview and course outline. If students are interested in selecting the course, they can select the course to be reviewed by the opening teacher. After receiving a student's course selection application, the teacher can view the basic personal information and previous learning of the student. If the teacher agrees with the students to choose their own courses, then the topic selection is successful, and the students can start learning the courses [10, 11].

The system database includes the following three modules, a total of 12 tables:

- (1) Basic information related modules: school and school system maintainer table SchoolList, college table CollegeList, teacher table TeacherList, administrative class table NatureClassList, student information table StudentList
- (2) Course information related modules: course list, course chapter list CourseListt, courseware list CoursewareList, and test topic list ContentTestList
- (3) Modules related to students' questions: StuCourseList, StuAnswer, and StuScore

Course List is used to store information about courses offered by teachers in the system. The data structure of table Course List is shown in Table 2.

The Course Chapter table ChapterList is used to store the relevant information of the course chapters in the system. The data structure of table ChapterList is shown in Table 3.

The test question table ContentTestList is used to store the standardized test question information under the corresponding chapter of the course in the system. There may be multiple standardized test questions under a chapter. There are three types of test questions: single choice questions,

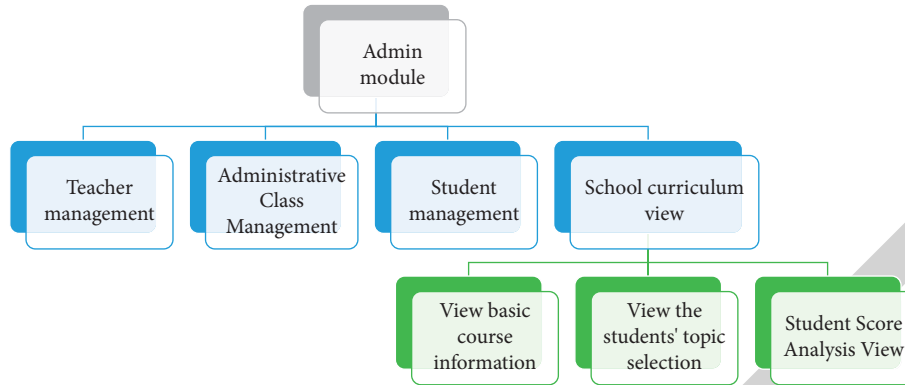


FIGURE 5: Schematic diagram of online intelligent learning system—administrator role—submodule.

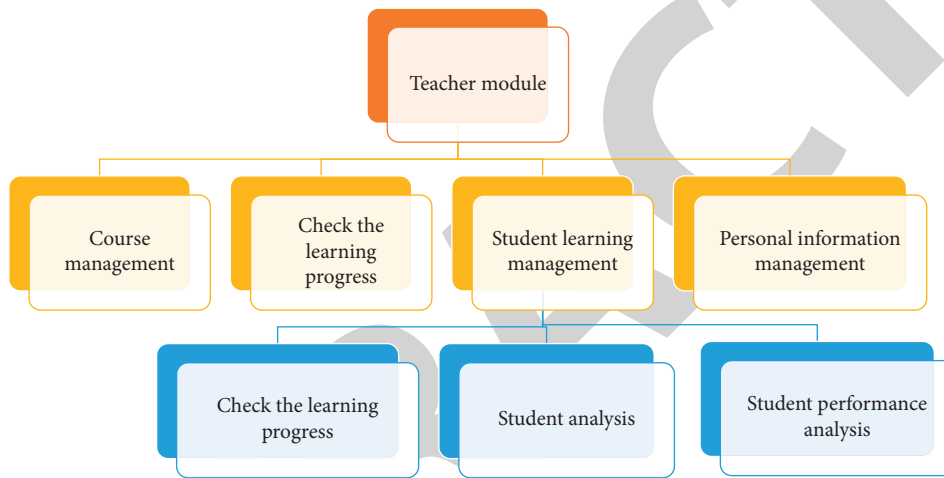


FIGURE 6: Schematic diagram of online intelligent learning system: teacher role submodule.

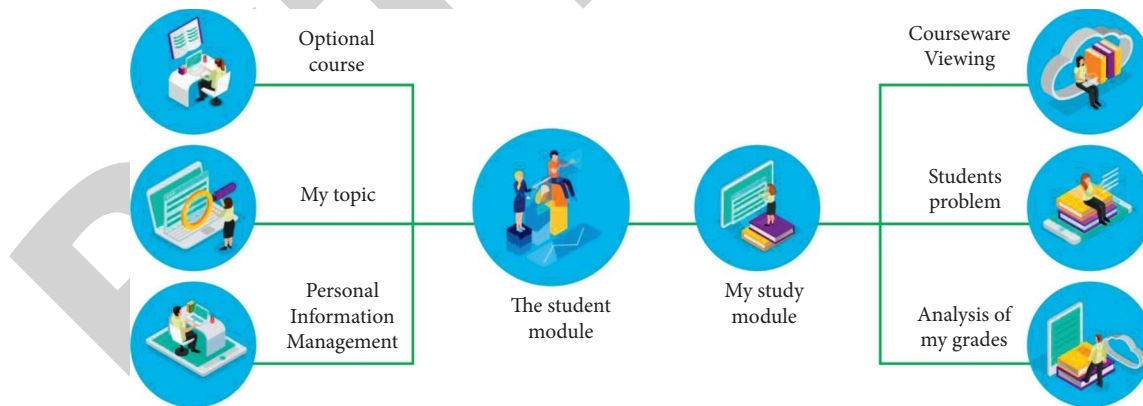


FIGURE 7: Schematic diagram of online intelligent learning system: student role submodule.

multiple choice questions, and judgment questions. The data structure of table ContentTestList is shown in Table 4.

The student course selection table StuCourseList is used to store relevant information about student course selection in the system. The data structure of table StuCourseList is shown in Table 5.

3.3. Database Design. The design of system database can greatly affect the performance of the system. Reasonable database design can make the system speed up the search in the process of related business processing. Before the database form design, it is necessary to design the database form in strict accordance with the actual needs of users and

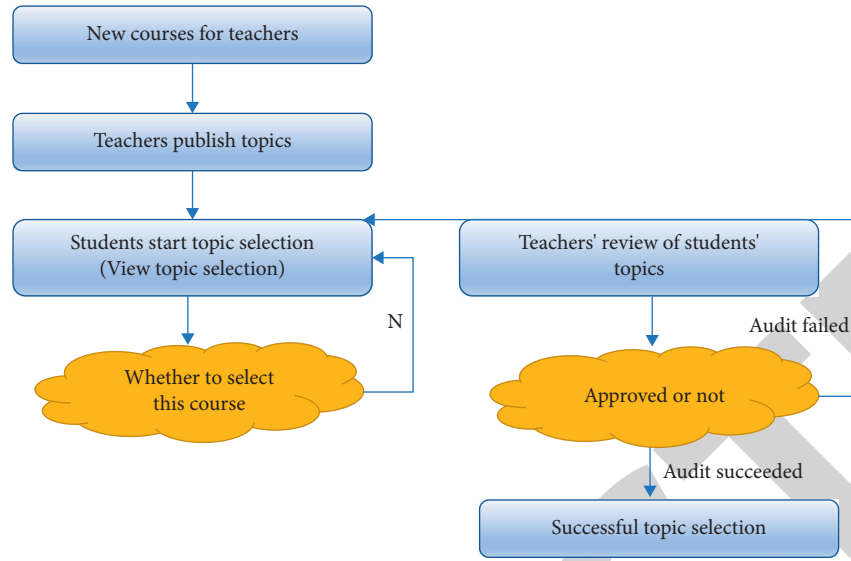


FIGURE 8: Online intelligent learning system: schematic diagram of topic selection process.

TABLE 2: Structure of CourseList.

Number	Field name	Data type	Explain
1	COURSE_ID	CHAR (36)	Course ID, primary key, null string allowed (no)
2	TEACHERID	CHAR (36)	ID of the teacher to which the course belongs. Foreign key, allow empty string (no)
3	COURSE_NAME	VARCHAR (100)	Course name, required field (yes), null string allowed (no)
4	COURSE_START	VARCHAR (20)	Start time, required field (yes), null string allowed (no)
5	COURSE_END	VARCHAR (20)	End time, required field (yes), null string allowed (no)
6	STATUS	CHAR (1)	Status, the default value is 0 0-course valid, 1-course invalid
7	COURSE_MEMO	VARCHAR (5000)	Course introduction

TABLE 3: Structure of Course Chapter table ChapterList.

Number	Field name	Data type	Explain
1	Nodeld	CHAR (30)	Node ID, primary key, null string allowed
2	COURSE_ID	CHAR (30)	Teacher ID of the node, foreign key, null string allowed (no)
3	Node order	CHAR (2)	Node sort number
4	NodeName	VARCHAR (20)	Node name, required field (yes), null string allowed (no)
5	IsChapter	CHAR (2)	Chapter or not, the default value is 0 0-section, 1-chapter
6	ChapterID	CHAR (30)	Parent chapter ID, which is null by default. When isChapte is 0, the column needs to fill in the NodeID of the parent chapter

TABLE 4: Structure of test topic table ContentTestList.

Number	Field name	Data type	Explain
1	ContentTestID	CHAR (30)	Courseware ID, primary key, null string allowed (no)
2	Nodeld	CHAR (30)	Courseware node ID, foreign key, null string allowed (no)
3	ContentTestName	VARCHAR (20)	Back dot name, required field (yes), null string allowed (no)
4	Order	CHAR (2)	Courseware sorting number
5	Type	CHAR (2)	Test question type. The default value is 0 0-single choice, 1-multiple choice, 2-judgment
6	TaskContent	VARCHAR (5000)	Title content, required field (yes), null string allowed (no)
7	RightAnswer	CHAR (10)	Title answer, required field (yes), null string allowed (no)
8	ScorePoint	Char (2)	Title score, required field (yes) allow empty string (no)
9	CREATE_DATE	VARCHAR (20)	Creation date in the format of yyyyymmdd. Empty string is allowed (no)
10	CREATE_USER	CHAR (36)	Created by allow empty strings (no)

TABLE 5: Structure of StuCourseList.

Number	Field name	Data type	Explain
1	COURSE_STUDENTS_ID	CHAR (36)	Student course selection ID, unique keyword, primary key, null string allowed (no)
2	STUDENT_ID	CHAR (36)	Student ID
3	COURSE_ID	CHAR (36)	Course ID
4	STATUS	CHAR (1)	Status, the default value is 0 0- course selection is valid, 1- invalid course selection
5	CREATE_DATE	VARCHAR (20)	Creation date in the format of yyyyymmdd. Null string is allowed (no)

the functional requirements of the system. It takes a certain amount of time to improve the database. According to the requirement analysis, the fields and forms in the database are designed strictly, and the database design is realized according to the normative design style. According to the actual situation, the functional modules of the system are mainly divided into virtual classroom management, music appreciation function, course live teaching function, and streaming media resource management function. Corresponding to these functional modules, they have their own corresponding database forms. The following is a specific introduction to the important forms [12].

3.3.1. Student Information Form. The student information form mainly stores some basic information of students. It mainly includes the storage of students' Student ID, name, password, nickname, contact information, and other personal information. The student ID is used as the primary key for storage. The student ID is automatically generated by the system. Each student user has a unique student ID corresponding to it. Other basic information of students can be accessed and called through the student ID. The details are shown in Table 6.

3.3.2. Teacher Information Form. The teacher information form mainly stores the basic personal information of the teacher user, focusing on the storage of basic personal information such as the teacher user's number, name, password, and contact information. The teacher number is used as the primary key for storage. The teacher number is automatically generated by the system. Each teacher user has a unique number corresponding to it. You can access the information of other fields in the form by numbering. Table 7 shows the specific teacher user form information [13].

3.3.3. Administrator Information Form. In order to ensure the system security, the relevant information logged in by the system administrator is generated into the system log. See Table 8 for details.

3.3.4. Virtual Classroom Information Form. The virtual classroom information form is mainly used to store some basic information of the virtual classroom. The main fields include classroom number, classroom size, and creation time. The creator is the foreign key of the teacher name in the teacher form. Table 9 shows the specific information of the virtual classroom form.

3.3.5. Electronic Courseware Table. The electronic courseware information form is created for the course management function in the system. It is used to record the courseware information uploaded by teachers, mainly including the storage of visible number, producer, applicable courses, number of people, and other basic information. Table 10 shows the specific contents of the courseware form [14].

3.4. Realization of the Music Education Teaching Management Information System

3.4.1. System Implementation Ideas. The implementation and development of this system will use the standard MVC development architecture, use vs 2010 under Windows environment as the development platform, and use https://asp.net technology to realize each functional module of the system. The system database uses SQL Server 2008 to store data. The following aspects should be paid attention to in the realization of system functions.

(1) *Accuracy.* The accuracy of system functions means that the functions corresponding to the modules divided in the system need to be clear so that users can use the system functions more conveniently. In the process of developing and implementing this system, we also need to pay great attention to the fact that developers need to closely follow the user needs to design, so as to avoid the occurrence of the discrepancy between the developed and designed functions and requirements. The adjustment of some functional modules of the system due to unclear functions or requirements is very resource-consuming. Therefore, in the process of development, attention should be paid to the accuracy of functions.

(2) *Stability.* System stability refers to the ability of the system to operate normally under various conditions and to bear a certain amount of heavy load access. Attention should be paid to the configuration of the server on the hardware and to the handling of some exceptions on the software. For example, when operating on the web client, try to avoid the occurrence of error pages. For some wrong operations, more humanized prompts can be used. The stability of the system can be guaranteed after the preliminary pressure test of the system.

(3) *Compatibility and Scalability.* Compatibility and expansibility means that the system needs a certain development space. The needs of users may change with the passage

TABLE 6: Student user table.

Field name	Type	Primary key	Foreign key	Can it be blank	Explain
StudentID	Int	Y	N	N	Student ID
Name	Varchar (50)	N	N	N	Full name
Password	Varchar (50)	N	N	N	Password
Nickname	Varchar (50)	N	N	N	Nickname
Sex	Varchar (5)	N	N	N	Gender
Age	Int	N	N	N	Age
E-mail	Varchar (50)	N	N	Y	E-mail
Address	Varchar (50)	N	N	Y	Contact address
Telephone	Varchar (20)	N	N	Y	Contact number
PicPath	Varchar (100)	N	N	Y	Photo path
Balanced	Int	N	N	N	Card balance
Grade	Int	N	N	N	User level
RegTime	Date	N	N	N	Registration time
Comments	Varchar (200)	N	N	Y	Remarks

TABLE 7: Teacher user table.

Field name	Type	Primary key	Foreign key	Can it be blank	Explain
TeacherID	Int	Y	N	N	Teacher ID
Name	Varchar(10)	N	N	N	Full name
Password	Varchar(20)	N	N	N	Password
Age	Int	N	N	N	Age
Sex	Varchar(5)	N	N	N	Gender
E-mail	Varchar(50)	N	N	Y	E-mail
Address	Varchar(50)	N	N	Y	Contact address
Telephone	Varchar(20)	N	N	Y	Contact number
Grade	Int	N	N	N	Qualification level
PicPath	Varchar(100)	N	N	N	Photo path
RegTime	Date	N	N	N	Registration time
Comments	Varchar(200)	N	N	Y	Remarks

TABLE 8: System administrator table.

Field name	Type	Primary key	Foreign key	Can it be blank	Explain
AdminID	Int	Y	N	N	Administrator number
AdmType	Varchar (20)	N	N	N	Accounts
Password	Int	N	Y	N	Password
Name	Data	N	N	N	Full name
LastTime	Date	N	N	N	Last login time
LastIP	Date	N	N	N	Last login IP
Comments	Varchar (200)	N	N	Y	Remarks

TABLE 9: Table of virtual classroom.

Field name	Type	Primary key	Foreign key	Can it be blank	Explain
ClassID	Int	Y	N	N	Classroom no
ClassType	Varchar (20)	N	N	N	Classroom type
Creator	Int	N	Y	N	Creator
CreTime	Data	N	N	N	Creation time
CourseNum	Date	N	N	N	Number of courses
StudentNum	Date	N	N	N	Number of students
Comments	Varchar (200)	N	N	Y	Remarks

TABLE 10: Electronic courseware table.

Field name	Type	Primary key	Foreign key	Can it be blank	Explain
VideoNum	Int	Y	Y	N	Courseware no
VideoType	Int	N	N	N	Courseware type
Author	Int	N	Y	N	Producer
CourseID	Varchar (20)	Y	N	N	Course
CourseCN	Varchar (200)	N	N	Y	Courseware content
Time	Time	N	N	N	Courseware duration
PlayCount	Int	N	N	Y	Audience
Comments	Varchar (200)	N	N	Y	Remarks

of time. Therefore, some program interfaces need to be added in the process of development and design to facilitate the further improvement of system functions in the subsequent process. Compatibility means that the system can be compatible with a variety of operating environments. Since the system adopts b/s network application architecture, it is necessary to ensure the stability of system functions for different browser versions; that is, the compatibility ability must be guaranteed [15, 16].

(4) *Code Reusability*. In the development process, it is necessary to develop according to the standard development mode. And it should be noted that, for some repeated code fragments, code reuse technology can be used to reduce the development cost and shorten the development cycle, so as to improve the development efficiency, and code reuse can ensure the stability of the system code to a certain extent.

4. System Performance Test

4.1. Test Method

4.1.1. Module Test. Module test is mainly to test the function of each functional module in the system. During the test of the system, the black box test method will be adopted, mainly aiming at whether the relevant functional logic of the system is tight, whether some data inputs can be correctly responded to, and whether some illegal inputs can be intercepted [17]. For example, in the form input of the page, if you enter a blank value or some meaningless value, the system can make a correct response. For some fields, specific data type definitions are given in the system code.

4.1.2. Function Test. The function test is mainly to test the overall operation logic of the system, which is mainly divided into three aspects, including specific function test, logic effectiveness test, and system load test. The function test mainly aims at whether the operation logic in the system is normal and whether it can make correct response to various requests of users. The specific function test ensures the practicability of the system to a certain extent. Logical validity test refers to whether the system can meet the most basic needs of users, whether the system can work in different environments, and whether the text display information is correct. System load test refers to whether the

system can operate normally and display effect and system response time when the number of visits is very large.

4.1.3. Assembly Test. Assembly testing refers to testing the interfaces of the modules that have been implemented in the system by assembling them into a whole. The specific content is to check whether the output result is correct by entering different data. Through the combination of different modules, input and output tests are carried out to make the system more functional.

4.1.4. Safety Test. Security test is the guarantee of system security. In this system, the security vulnerability that needs attention is mainly the input detection of some forms. The system automatically filters out the illegal input in the table to prevent the attack in the form of SQL injection that affects the system security [18].

4.2. Test Cases and Results. The table used for the test is as follows: The virtual classroom test case is represented by the creation function. The virtual classroom is created by the teacher user. The teacher clicks the "create" button and fills in the corresponding form information. After that, the system creates a virtual classroom according to the data entered by the user. Table 11 shows the specific virtual classroom test case table.

The test of students' application to join the virtual classroom is mainly aimed at the students' correct login to the system. After searching and browsing the virtual classroom information, click the "apply to join" button, the system will respond successfully, and the student information will be entered into the system database. After receiving the relevant notification information, the old teacher can view the information of the new students in the student information list [19]. Table 12 shows the functional test case table of the specific student virtual classroom.

The music playing function test is for all users of the system. After entering the system, click the corresponding module to enter the music playing interface, select the music you want to play, click play, and the system successfully responds and starts playing. And the fluency of the music in the playback process is also one of the test content indicators. Table 13 shows the specific music playing test cases.

The live teaching function test of the system is aimed at the teachers and students in the system. The teachers and students have different permissions and need to be tested

TABLE 11: Creating the classroom test case table.

Test plan	Specific description
Product name	Online music teaching system
Function module name	Virtual classroom management module
Test function point	Create virtual classroom
User oriented	Teacher users
Test purpose	Verify whether the teacher user can create the virtual classroom normally
Testing procedure	(1) Teacher user login system (2) Set basic information of virtual classroom (3) Click the create button
Expected results	The virtual classroom was successfully created and assigned to the classroom number

TABLE 12: Test cases for applying to join the classroom.

Test plan	Specific description
Product name	Online music teaching system
Function module name	Virtual classroom management module
Test function point	Apply to join the virtual classroom
User oriented	Student users
Testing procedure	(1) Student users log in to the system (2) View the list of virtual classrooms and select the virtual classroom you want to join (3) Click the “apply to join” button
Expected results	The system sends the student user’s request to the teacher user

TABLE 13: Test cases of playing music.

Test plan	Specific description
Product name	Online music teaching system
Function module name	Performance appreciation module
Test function point	Play song
User oriented	Teachers, students, and tourists
Testing procedure	(1) Enter the performance appreciation module (2) View the system song library list (3) Select a favorite song to play
Expected results	The selected song can be played smoothly

separately. Student users can normally watch the live broadcast content of the teacher, and the quality and fluency of the live video are within the controllable range. Teacher users can normally apply to the system for live broadcast, and the system correctly responds to broadcast the live broadcast content of teachers to student users. Table 14 shows the test cases of live video broadcasting.

The course management function refers to the course management module of the teacher in the system, which can normally add, delete, modify, and edit courses. The users are teachers. Teachers can create new courses, delete existing courses, and operate the system database accordingly. Table 15 shows the course management test case table.

The system security test aims at the detection when users need to input forms in the system. In these places, the system needs to detect some illegal input from users to prevent malicious attacks. The system can automatically identify malicious codes and filter them out. Table 16 shows the security test cases of the system.

4.3. Performance Test Analysis. For system performance analysis, a very mature simulation test system that has been developed at present can be used for system detection. The load capacity of the system is tested by automatic test method. Through the load function test, we can intuitively see how the performance parameters of the system are under different loads. In addition, the critical value of the traffic that the system can withstand can be obtained through the stress test method. Through the understanding of this point, the system performance can be further improved. The system performance analysis ensures the stability of the system to a certain extent, enabling the system to adapt to a variety of environments and operate normally [20].

Mercury’s load runner tool can be used to test the scalability of the system and the load capacity of the system. During the test, the response time of the website application under massive access is mainly simulated. Before the system is formally put into operation, the stability of the system can be guaranteed through certain performance tests. As many unexpected situations may be encountered in real situations, it is very necessary to adopt highly integrated and excellent performance test software. The load runner software can analyze the functions of the system layer by layer and can simulate many users to use the system. Testing with this software can ensure the normal operation of the system in a variety of complex situations to a certain extent.

Mercury load runner is a test software often used in the industry. It can accurately test the system performance before it is launched and provide a detailed and specific system performance analysis report. At the same time, it can also analyze the scalability of the system, generate the corresponding report files, and visually express the scalability of the information system, preventing many mistakes in the formal operation of the system. Load runner can

TABLE 14: Test cases of live video broadcasting.

Test plan	Specific description
Product name	Online music teaching system
Function module name	Live classroom module
Test function point	Live video
User oriented	Teacher user
Testing procedure	(1) Start online live broadcast service (2) Capture video signal with digital video camera (3) The video signal is transmitted to the live broadcast server
Expected results	The live broadcast server outputs streaming video signals

TABLE 15: Course management test case table.

Test plan	Specific description
Product name	Online music teaching system
Function module name	Management panel module
Test function point	Course management
User oriented	Teacher users
Testing procedure	(1) Teacher user enters the management panel module (2) Show all courses created by this teacher (3) Select a course to edit
Expected results	Can add, delete, and edit courses

TABLE 16: Table of safety test cases.

Test plan	Specific description
Product name	Online music teaching system
Function module name	Any module
Test function point	Security management
User oriented	Teachers and students
Testing procedure	(1) Teachers or students log in to the system (2) Select any module and enter malicious query code (3) Click submit
Expected results	Malicious query code is blocked by the system

measure the performance indicators of the main business in the system. And this test software is now able to test the performance of the system in real time with the continuous development of information technology. It can collect more system operation data. By capturing these details, load runner can analyze these data in detail through its own algorithm logic and obtain accurate performance analysis reports.

Load runner enjoys a high reputation in the industry. It supports convenient tests including system performance and scalability for all kinds of information systems in all walks of life. It is also a performance testing tool tailored to the ERP/CRM environment of Oracle and Siebel. The software itself adopts J2EE platform, including Microsoft's .Net platform integrated in the software, so it covers a wide range of fields. Through these tools, it is more convenient to test the information system accurately in all aspects.

Through the use of a series of test tools, the online music education system is tested under 200, 400, and 800 user visits. By determining the system response time and other data as index parameters, these index parameters are tested

to realize the detection of the overall function of the system and finally get an accurate analysis section report. The results of the pressure test on the system through the tool consist of the following aspects:

- (1) User visits: 200, 400, 800.
- (2) Pacing: 60 seconds.
- (3) The user successfully accesses the system and stays in the system for 20 minutes for continuous operation.
- (4) User scheduling: 30 virtual users/s. From Figure 9, we can see the response time curve of the system under different user visits. From this curve, we can conclude that the system is in good condition when 200 people visit the system within 2.5 s. However, with 300 or 500 visitors, the system performance exceeds 3 s, which will bring bad experience to users. When the system cannot access a large number of users, it will maintain a certain performance level, and the system load capacity needs to be improved.

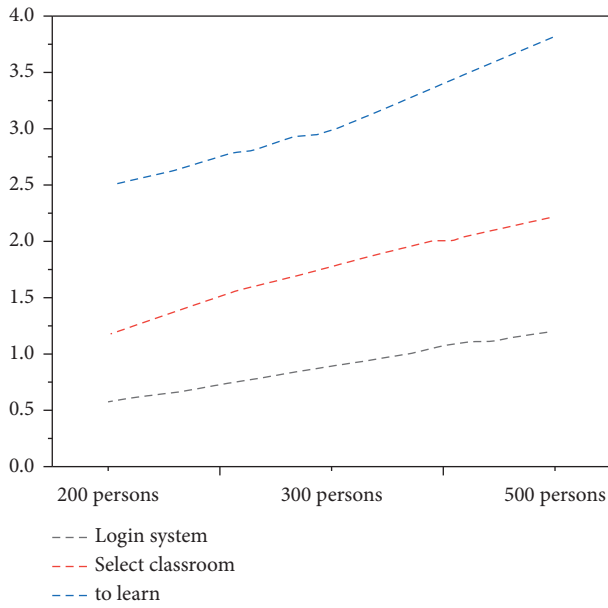


FIGURE 9: Response time curve.

Through the test of all aspects of the initially completed system, the specific content is to briefly introduce the test methods, and to apply each method, a specific test case table is given. The results show that the system works well in performance, but the performance under heavy load needs to be improved.

5. Conclusion

This paper mainly describes the management of related knowledge and working technology of online network teaching system, as well as two model technologies (b/s and c/s), as well as the application of security and network technology and database technology. Through the above technical learning, our project researches and designs a set of special online music teaching system. Main contents of this article are as follows:

- (1) First of all, this paper investigated many teaching related institutions and made a questionnaire survey on some teachers and students to determine the subject. Then, through going to the library to learn relevant knowledge and obtaining information on the Internet, we can learn and understand relevant technologies. We have a deep understanding of the current teaching system, especially the online music teaching system. In addition, in order to realize the development of the system, the author studied Visual Studio 2010, <https://ASP.NET>, and SQL Server 2008.
- (2) For the design and implementation of the system, we mainly have the following four aspects. First, we design according to the design principles and design requirements. Secondly, we designed and realized the connection between the main interface and other interfaces of the system. Then, the design of system function is realized. Finally, the design of database is

realized. Using streaming media and live broadcast technology, an online teaching system for music teaching is designed to realize the characteristic functions of live broadcast classroom and performance appreciation.

- (3) After the system is improved, it needs to be tested. The system functions are determined by analyzing the system implementation. We generally use the black box test method when testing the system. When testing the system, we are based on the test plan and design, which can better achieve the purpose of testing. There are still unsolved problems in the security design of our system. For example, if we only rely on the user's account name and password to log in to our system, we cannot achieve the security label. Because there are still many places in the system with high security requirements, simple security settings cannot play a protective role. Therefore, there are many places in the system that need to be improved. Some problems can be exposed through the later use of the system, and then we can improve and perfect it.

Due to the rapid development of information network and its penetration and application in all walks of life, the informatization of education industry is also the trend of the times. Therefore, we need to actively apply informatization to education. Improving teaching quality and overall teaching level through information technology is one of the steps of contemporary corresponding information reform. At present, there have been many information-based education systems, all of which are striving to build a better education quality. The advantage of information education is that teaching can be carried out at any time and anywhere and the richness of resources, which is lacking in traditional education. This paper is an attempt to develop a courseware making system based on education, hoping to exchange and learn from each other. In the future research work, we will continue to learn to make the system more perfect.

Data Availability

The labeled data set used to support the findings of this study is available from the author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

Acknowledgments

This work was supported by the Hebei Institute of Communication College.

References

- [1] Z. Wei, G. Zhai, Z. Wang, W. Wang, and S. Ji, "An artificial intelligence segmentation method for recognizing the free surface in a sloshing tank," *Ocean Engineering*, vol. 220, no. 4, pp. 108488–108492, 2021.

Retraction

Retracted: Piano Teaching Improvement Based on Machine Learning and Artificial Intelligence

Security and Communication Networks

Received 17 October 2023; Accepted 17 October 2023; Published 18 October 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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.

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] N. Zhang, "Piano Teaching Improvement Based on Machine Learning and Artificial Intelligence," *Security and Communication Networks*, vol. 2022, Article ID 9672068, 11 pages, 2022.

Research Article

Piano Teaching Improvement Based on Machine Learning and Artificial Intelligence

Nan Zhang 

Sports Department of Cangzhou Normal University, Cangzhou, Hebei 061000, China

Correspondence should be addressed to Nan Zhang; zhangnan0808@caztc.edu.cn

Received 22 June 2022; Revised 20 July 2022; Accepted 6 August 2022; Published 24 August 2022

Academic Editor: Tao Cui

Copyright © 2022 Nan Zhang. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

With the development of modern piano and the increasing demand of people for music hobbies, the traditional piano teaching mode had exposed more and more problems. Artificial intelligence accelerated the development of music education to a certain extent and effectively improved the teaching effect of teachers to piano lovers. If artificial intelligence and machine learning were organically integrated, the application of intelligent piano can be more wide. Therefore, this paper proposed a piano teaching model based on machine learning and artificial intelligence, which aimed to provide support for improving the quality of piano teaching. Firstly, based on the analysis of machine learning-related theories, this paper expounded the characteristics of neural network in data processing and gave the process of the integration of machine learning and artificial intelligence and its application advantages in music teaching. Secondly, according to the interactive needs between intelligent piano and learners, this paper put forward intelligent piano teaching assistance methods and constructed an intelligent piano teaching service management system by improving the teaching information resource base. Finally, it analyzed the influence of artificial intelligence on piano teaching from different angles. In order to test the effectiveness of the piano teaching mode proposed in this paper, the piano learners under different teaching modes were investigated and counted. From the piano teaching effect and the evaluation results of the piano practitioners on the teaching mode, it was known that compared with the traditional piano teaching mode, the piano teaching mode proposed in this paper had achieved remarkable results in both theoretical teaching and practical operation. It can significantly improve the quality of piano teaching and promote the enthusiasm of learners.

1. Introduction

In recent years, with the continuous deepening of the application of deep learning technology, artificial intelligence has ushered in new development opportunities in some fields. In addition to being able to deal with some specific daily things, artificial intelligence has gradually demonstrated the wisdom of helping human beings jointly solve many problems [1]. Therefore, artificial intelligence has attracted extensive attention in more and more application fields. For example, in the field of medical application, in order to accurately diagnose the patient's condition, doctors mainly rely on long-term accumulated clinical experience, while artificial intelligence doctors can use deep learning algorithm to determine the condition in a short time by retrieving the case database and formulate specific treatment

plans at the same time [2]. The research shows that deep learning technology promotes the application of natural language recognition to a certain extent, and produces some well-known virtual assistants. For example, people can distinguish language information from different users in indoor places. Combined with the increasingly mature Internet of things technology, users can effectively control household appliances through virtual assistants, which not only greatly facilitates people's lives, but also meets the various needs of different users.

It is known from the existing research that artificial intelligence is mainly to transplant human's ability to recognize and process things to different machines and equipment, so that machines can provide some services for human beings [3]. With the rapid development of electronic technology, communication technology, and computer

technology in the field of music education, piano education has gradually got rid of the shackles of the traditional teaching mode. By constantly improving the relevant facilities and using artificial intelligence technology to meet the various needs of piano lovers, intelligent piano has emerged. Intelligent piano not only follows the basic characteristics of traditional piano, but also uses advanced machine learning and artificial intelligence technology to change the playing mode. By adding some auxiliary equipment and auxiliary teaching system, the intelligent piano not only has the function of tuning and mute, but also can switch between the traditional piano pronunciation and electroacoustic pronunciation, thus providing a hardware foundation for the realization of intelligent music score, online piano practice, piano distance teaching, and communication interaction [4].

With the development of artificial intelligence technology, intelligent piano has had a certain impact on music education. Although artificial intelligence has promoted the development of music education and replaced part of human work to a certain extent, it still needs to be continuously improved due to the integration of artificial intelligence and other technologies [5], for example, how to give play to the auxiliary function of artificial intelligence in piano teaching, stimulate the interest and enthusiasm of piano practitioners, and provide services for teachers to better improve teaching quality. At present, intelligent piano teaching only allows practitioners to complete some basic learning independently through the separation of teaching and learning, lacking some interactive functions, thus affecting the popularity of intelligent piano. However, there are still many problems to be solved for the details and in-depth learning in the process of piano practice. Therefore, based on the theory of machine learning and artificial intelligence, combined with the needs and characteristics of piano teaching, this paper puts forward an intelligent piano auxiliary teaching and management method, which provides a certain reference for modern piano teaching.

2. Related Works

According to the research results obtained in recent years, the application of machine learning, computer vision, and artificial intelligence in various fields has achieved good results. With the increasing demand of people for spiritual life, some researchers began to apply artificial intelligence technology to the entertainment field and achieved some results [6]. For example, game AI enables game lovers to play different roles by interacting with players, which not only enriches game content, but also enhances people's awareness and experience of entertainment. In recent years, game designers have begun to use artificial intelligence technology to develop some highly intelligent game software in order to attract more game lovers to participate in the interactive experience of the game [7]. Generally, the methods of applying artificial intelligence to game design mainly include finite state machine and behavior tree, but the workload of using these methods to design intelligent game software is large and difficult to maintain. For this reason, people adopt

the organic integration of artificial intelligence and machine learning, for example, using machine learning methods to train game software that meets the needs of users and has strong adaptability.

With the popularization of artificial intelligence technology in the entertainment industry, the traditional way of entertainment has been greatly impacted. For example, intelligent piano has been favored by many piano lovers because of its integration into artificial intelligence technology, which has also changed the traditional piano teaching mode [8]. Intelligent piano is not only the integration of new electroacoustic technology, artificial intelligence technology, automatic control technology, and network communication technology, but also the product of the development of traditional piano. It effectively solves the problems of traditional piano in terms of education mode, class time, and space. Therefore, intelligent piano can meet the needs of modern music education. For example, the intelligent piano can use the live video to accompany the piano practice. In particular, there is no need to make an appointment in advance for the intelligent piano practice. Learners can interact with the instructor through the intelligent piano practice system at any time and report their daily piano practice to the teacher [9]. The piano teacher can view the learners' learning duration, training content, and existing problems in the background, and solve the learners' shortcomings in the process of practicing the piano in real time through the intelligent sparring system.

The research shows that the application potential of artificial intelligence in the field of music teaching has not been brought into full play due to the influence of people's different levels of music cognition. Artificial intelligence can help people analyze complex data and make it logical by integrating data resources. For example, after inputting some basic music theory knowledge into the machine database, the use of artificial intelligence technology to analyze and process the basic knowledge in the database can provide regular guidance for learners [10]. By constantly adding learners' thinking and emotional element words to the machine database, the machine can provide intuitive guidance for learners through multi-level thinking. Using artificial intelligence technology, the tunes and notes in music works can be generated into virtual scenes, so that practitioners can intuitively feel the emotional charm of music, so as to stimulate students' enthusiasm and interest in music. At present, in the teaching process of basic music courses, artificial intelligence can enable students to master basic knowledge and improve their music literacy through basic learning [11]. However, due to the lack of due knowledge background and cognitive ability, artificial intelligence technology can still not be applied to piano teaching in the advanced stage.

However, restricted by different software and hardware technologies and their applications, the development of intelligent piano is still in the trial stage, with both great opportunities and challenges [12]. Although the smart piano integrates relevant artificial intelligence and Internet of things technologies, the traditional piano teaching mode and offline training institutions still have a great impact on most

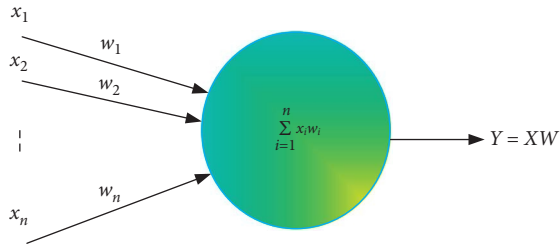


FIGURE 1: Working diagram of artificial neuron.

practitioners. Therefore, in the future, the smart piano needs to be recognized by piano lovers by continuously increasing the user base and enriching the course content. In addition, most of the existing intelligent pianos have some problems, such as imperfect functions, immature curriculum system, and single teaching methods. Therefore, it is necessary to promote the development of piano education from the perspective of perfecting the function of intelligent piano and improving teaching methods.

3. Machine Learning Theory

3.1. Artificial Neural Network Method. In order to obtain the best piano performance effect, we need to optimize various parameters that affect the performance. As the most basic artificial neural network model of machine learning, it is a nonlinear dynamic system that can deal with complex problems. It can take various external variable factors as training samples and extract relevant features through the training of neural network model, so as to obtain the optimal parameter combination. As a frontier field formed by interdisciplinary research in the twentieth century, artificial neural network is a complex nonlinear system. Artificial neural network contains several different neurons, and the system formed by a large number of neurons and networks is more complex. Similar to the general nonlinear system, artificial neural network has the characteristics of high dimension, continuity, and adaptability between different neurons.

Neuron is actually a mathematical model constructed by simulating biological neurons [13]. Its function is similar to biological neurons. The input-output structure model of neurons is shown in Figure 1.

In the artificial neural network model, each neuron can obtain a group of signals from other neurons in the network, in which each input signal has a weight corresponding to it, and the activation state of neurons is determined by the weighted sum of this group of input signals.

Suppose n inputs are represented as x_1, x_2, \dots, x_n , and the corresponding weights are expressed as w_1, w_2, \dots, w_n , which, respectively, constitute the input vector X and the weight vector W of the neuron, then the processing result of the neuron on the input signal can be expressed as

$$Y = \sum_{i=1}^n x_i w_i. \quad (1)$$

Before the application of artificial neural network, it is necessary to train the neural network model. The sample set

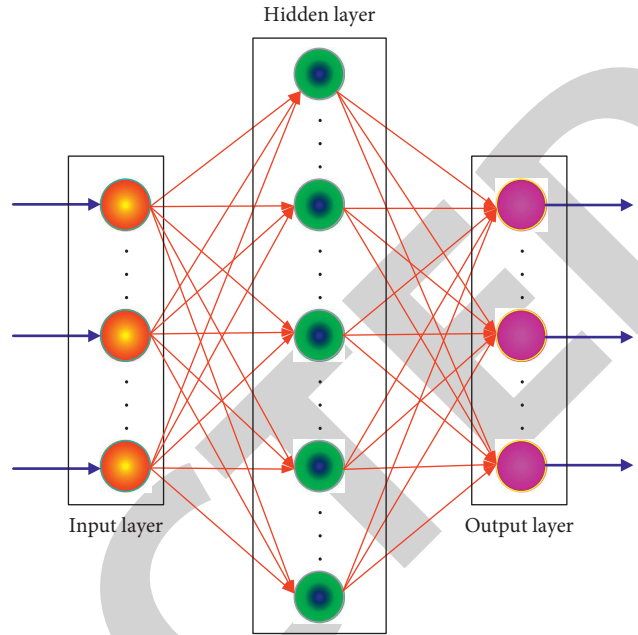


FIGURE 2: Structure diagram of BP neural network model.

is used as the input value of the neural network model to train the network model, and the weight values between neurons are dynamically adjusted, so that the neural network model can get the corresponding output results when receiving data input.

The training methods of artificial neural network are mainly divided into unsupervised training and supervised training. The unsupervised training method does not need to set targets, its training set contains some input signals, and for any input value, the weight value can be modified to make the network model get the corresponding output results. When training the network, the unsupervised training method can extract the relevant feature information from the training sample set, store it in the neural network, and then classify the input objects according to the similarity of the samples. Because the unsupervised training method is difficult to effectively predict the output results, it is limited in application.

When using the supervised training method to train the model, the input vectors of all samples are required to have corresponding output vectors. When the output of the neural network model is different from the predetermined output vector, the weight vector of the network needs to be adjusted according to the difference between the two. When using the supervised training method, first, take a sample (P_i, Q_i) from the sample set, where P is the input vector and Q is the predetermined output vector [14]. Secondly, the actual output O_i of the neural network model is calculated, and the error of the network model is calculated as follows:

$$Er = \frac{1}{2} \sum_{i=1}^n (Q_i - O_i)^2. \quad (2)$$

Finally, the weight vector of the network is adjusted according to the error value Er . Repeat the above operation

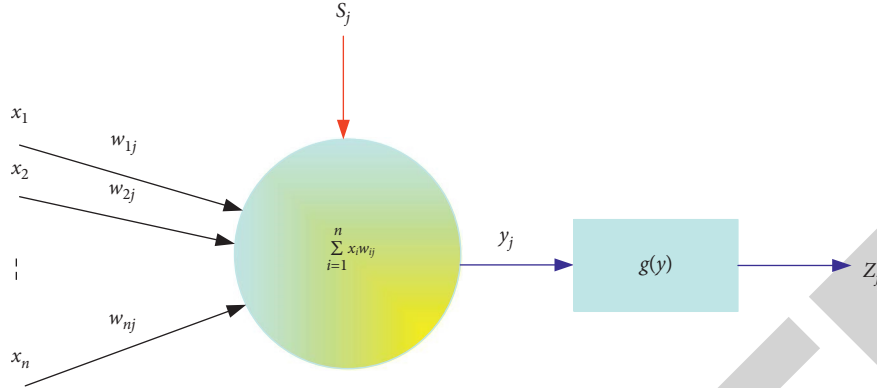


FIGURE 3: Working diagram of BP neuron.

process for each sample until the error of all samples in the sample set does not exceed the specified value.

In order to avoid describing the mapping relationship between the input and output of training samples through mathematical equations in advance, BP neural network can be used [15]. As one of the widely used neural network models, BP network can learn and store the mapping relationship between input and output of samples. The steepest descent method and back propagation are used to dynamically adjust the weight value of the network model until the sum of square errors of the network reaches the minimum. As shown in Figure 2, the topology of BP neural network model includes input layer, output layer, and hidden layer.

Similar to the neurons of other network models, BP neural network has the functions of weighting, calculating, and transferring input samples. As shown in Figure 3, $[x_1, x_2, \dots, x_n]$ represents the sample input from different neurons, and $[w_{1j}, w_{2j}, \dots, w_{nj}]$ indicates the connection strength between different neurons and the j -th neuron, that is, the weight vector. y_j is the threshold, $g(y)$ is the transfer function, and z_j is the output of the j -th neuron.

The net input value y_j of the j -th neuron can be expressed as

$$y_j = \sum_{i=1}^n x_i w_{ij} + s_j, \quad (3)$$

$$y_j = W_j X + s_j,$$

where the sample input from different neurons can be expressed as $X = [x_1, x_2, \dots, x_n]^T$ and the connection strength between different neurons and the j -th neuron is represented by $W_j = [w_{1j}, w_{2j}, \dots, w_{nj}]$.

After the net input y_j is processed by the transfer function $g(y)$, the output z_j of the j -th neuron can be obtained. Its calculation formula is as follows:

$$z_j = g(y_j) = g\left(\sum_{i=0}^n w_{ij} \cdot x_i\right) = g(W_j X), \quad (4)$$

where $g(y)$ is a monotonically increasing function. Since the signals transmitted by neurons are limited, $g(y)$ is a bounded function; that is, there is a maximum value.

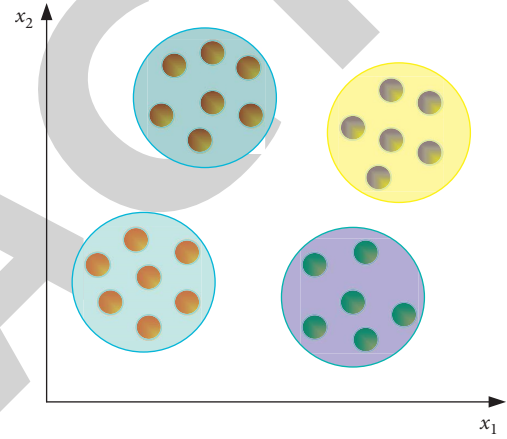


FIGURE 4: Schematic diagram of unsupervised learning and training.

BP algorithm includes two processes: forward propagation of data and back propagation of error. The direction of forward propagation is from the input layer to the hidden layer, and then to the output layer. The processing results of neurons in each layer directly affect the neurons in the next layer. If the output result of the output layer is different from the expected value, it is necessary to go to the back propagation process of the error. Through the continuous alternating processing of the two processes, the network error is minimized, and the feature extraction and storage are completed.

3.2. Machine Learning Category. As an important branch in the field of artificial intelligence, machine learning mainly obtains an applicable model from data through learning. Machine learning mainly includes three kinds of algorithms: unsupervised learning, supervised learning, and reinforcement learning. Each algorithm learns according to different types of data [16].

Unsupervised learning mainly uses clustering method to group similar objects in the data set, as shown in Figure 4. For example, smart piano can classify users according to learners' participation and divide learners into two

categories: high enthusiasm and low enthusiasm. On the basis of defining the relevant attributes of intelligent piano learners, different types of attribute information are weighted. Then, the input data of all learners are used as a data set for unsupervised learning algorithm. The algorithm can further divide the data of learners into two categories: one represents learners with high enthusiasm, and the other represents learners with low enthusiasm. Because the initial learner data set contains only basic attribute information, the initial learner data set is also called unlabeled data set. For the initial data set, unsupervised learning method can generate different types of tags in order to provide a basis for further data analysis. By using unsupervised learning algorithm, two types of tags with high enthusiasm and low enthusiasm can be mined [17].

Unlike unsupervised learning, supervised learning mainly learns each object and assigns it to different categories according to the results, as shown in Figure 5. Taking the above classification of intelligent piano learners as an example, in order to predict which learners will no longer participate in piano learning in the future, first of all, it is necessary to create a data set that contains not only the basic attribute information of learners, but also a label reflecting whether learners have given up piano practice. Then, taking this data set as the input of the supervised learning algorithm, the supervised learning algorithm processes the basic attributes of the learner and whether the learner will give up piano learning, and learns which attributes the learner will give up practicing the piano more easily, thus creating a learner prediction model. Therefore, according to the characteristics of new learners, the prediction model is used to output corresponding prediction labels to help piano teachers adjust the teaching methods of new learners. When using machine learning model to process and analyze data, whether supervised learning or unsupervised learning, it is necessary to select the attribute information of the input object and the corresponding model, so that the machine learning model can process data pertinently. Among them, the attribute information of the selected input object can reflect the expected label, and the selection model will affect the prediction ability of the new input data [18]. In addition, in practical applications, supervised learning and unsupervised learning usually need many iterations to achieve the desired results.

Reinforcement learning mainly adopts the method of sequential decision-making to learn the data set. Generally, it cooperates with the control robot and can be well applied in many fields. Taking the hand fingering in piano practice as an example, the CNN model can be used to detect and recognize the hand fingering features, and the common wrong gestures in performance can be used as a data set to strengthen the learning of the model [19]. According to the collected gesture information, the video hand recognition algorithm based on convolutional neural network is adopted to recognize the hands of the practitioners, and the CNN model is used to dynamically adjust the hands of the piano learners during practice [14]. By using the neural network of hand recognition, we can not only find the learners' incorrect hand fingering in time and feed back relevant

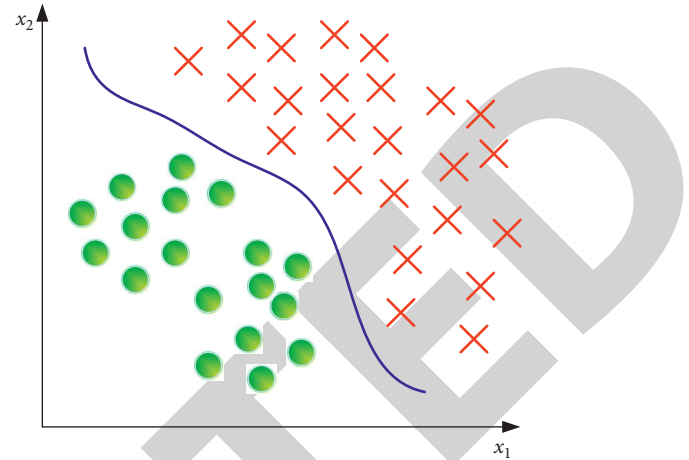


FIGURE 5: Schematic diagram of supervised learning and training.

information, but also compare the learners' performance with the standard repertoire and analyze the possible problems through the difference comparison.

Reinforcement learning belongs to a machine learning strategy, which mainly forms several related actions by observing objects and processing models. The process of observing objects is mainly to collect data by controlling sensors, while the process of action formation is to manipulate robot components or output results. Reinforcement learning model usually introduces reward mechanism to maximize the training effect. When training an intelligent piano practitioner, you can set the correct practice as a positive reward, and each error will give a negative reward, which will be given to the piano practitioner during the performance of the track [20]. By adopting the reward mechanism and the maximum reward strategy, piano practitioners can improve the performance effect through repeated training. Figure 6 shows the working process of reinforcement learning.

4. Piano Teaching Mode Based on Artificial Intelligence

4.1. Intelligent Piano Teaching Assistant Method. At present, the intelligent piano teaching method cannot be separated from the corresponding equipment support. The equipment can be built into the piano or connected to the piano as an independent accessory. No matter which method is adopted, the piano player depends on the contact detection of the keys when judging the specific keys. For example, the micro-switch of the piano can be used to detect the piano key. When the player presses the piano key, the switch will be turned on and the key signal will be transmitted to the sensing system. Although this method is very simple, it has a certain impact on the hand feel of players. Moreover, these external devices with independent accessories may affect the player due to their strict installation requirements.

In order to enable players to practice the piano and practice the piano well, an intelligent platform integrating different system resources can be adopted [21]. The

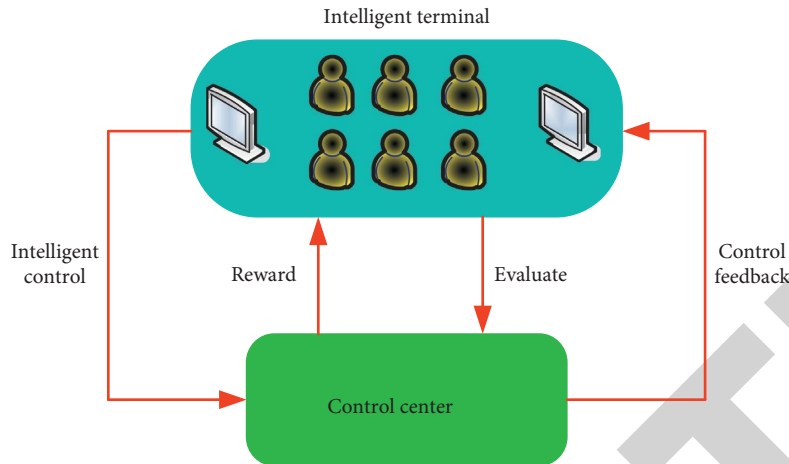


FIGURE 6: The working process of reinforcement learning and its application.

intelligent piano is generally composed of the intelligent system of the Internet of things and the piano. It not only maintains the traditional physical string striking method and sound production, but also uses the Internet of things technology to cross the space-time limit and realize human-computer interaction through the connection between pianos. The intelligent piano teaching assistant system can not only provide learners with various guidance services and high-quality resources, but also form a closed loop between piano learning and practicing, teaching and counseling, in class and out of class. It can not only improve the efficiency of teaching and learning, but also promote the reform of piano teaching.

Through the intelligent system of the Internet of things, the smart piano can not only collect and restore the playing sound, but also achieve the same playing strength and rhythm. At the same time, playing by imitating real people can achieve better results. With the associated function of the intelligent system of the Internet of things, learners can practice piano at home under the guidance of teachers through remote means. Teachers can not only conduct remote teaching, but also demonstrate for learners through video and piano keys at the same time, so as to restore the playing sound in real time. Through close interaction and experience, smart piano can not only improve the efficiency and enthusiasm of learners' piano practice, but also solve the problems of learners' inattention or difficulty in practicing. In addition, in the process of intelligent piano teaching, learners can truly feel the sound of piano body resonance rather than the sound of video transmission. From this, it can be seen that the intelligent piano teaching method is difficult to achieve in terms of accuracy and the sense of rhythm and rhythm of music. As shown in Figure 7, it shows the interactive process between intelligent piano and learners.

The traditional demonstration teaching method is that the teacher shows the material objects to the students in the teaching process, and obtains the required knowledge through actual observation or experience. This method of imparting knowledge can enable students to acquire intuitive perceptual knowledge to a certain extent and have a

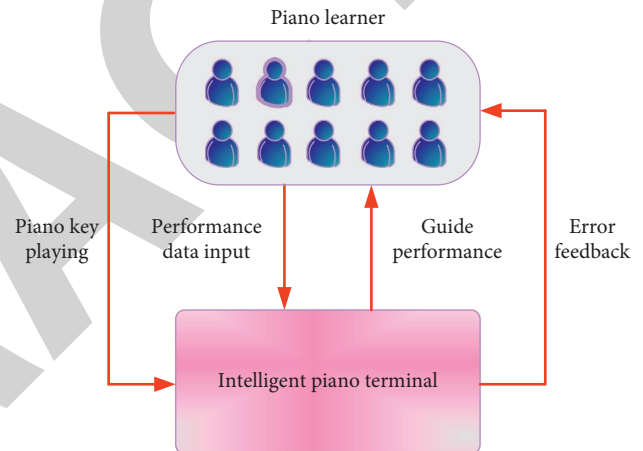


FIGURE 7: The interactive process between intelligent piano and learners.

deep grasp of the knowledge learned, so as to effectively link theory with practice. In the process of piano teaching, teachers' fingering, skills, and the use of pedals when playing the piano need to be shown to learners. However, due to the limitations of the piano itself, some display contents have limitations. Therefore, we can use artificial intelligence technology to establish an intelligent piano teaching assistant system. The system receives the signals from teachers' piano demonstrations from different angles and converts these signals into images or audio-visual output to terminal equipment. Through this "one to many" teaching mode, we can achieve real-time teaching for all students and then improve students' learning efficiency.

With the increasing number and demand of piano learners, the intelligent piano teaching assistant system can better meet the requirements of modern piano education only by integrating artificial intelligence technology with multimedia means and forming an interactive teaching mode. First of all, the intelligent piano-assisted teaching method needs to provide teachers with a teaching observation system. By installing a high-definition observation camera in the classroom, the teacher can control the

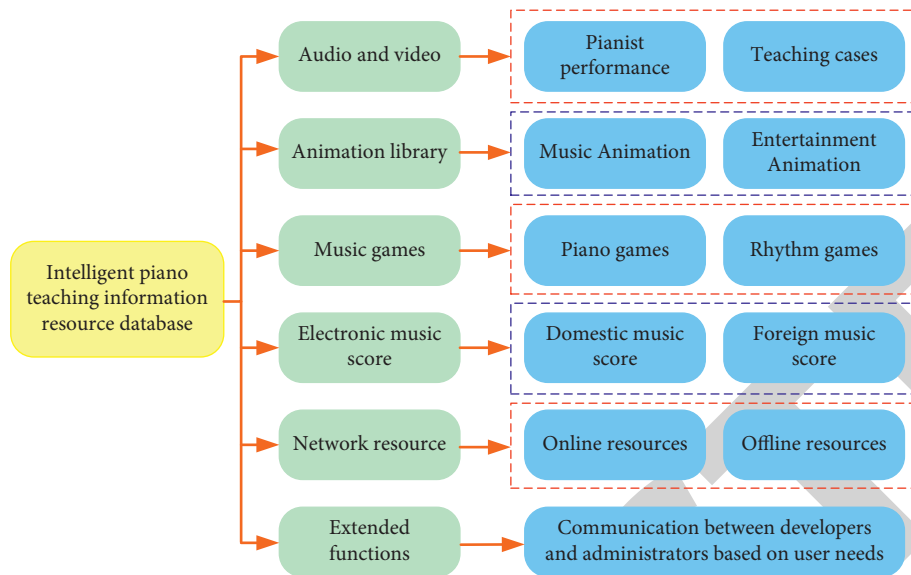


FIGURE 8: Intelligent piano teaching information resource database.

interactive teaching observation system and realize the movement of the camera in the teaching process. It can not only observe the performance of all students, but also correct errors and supervise the learning status of students in time. Secondly, the use of intelligent piano-assisted teaching method needs to provide students with an online consultation system. According to the signal sent by the student requesting the teacher, the teacher can control the observation camera, move it above the requester, and accept the student's online request, so as to realize the online guidance function. Using the function of online consultation system can avoid affecting other students' piano practice and distracting their attention.

4.2. Intelligent Piano Management System. The traditional piano teaching management usually has the problem of separation between teaching and learning, and the intelligent management system based on artificial intelligence technology can avoid the shortage of manual management. When piano learners practice independently in their spare time, students can view the homework tracks assigned by the teacher through the client of the intelligent management system [22]. At this time, the intelligent piano teaching service system can automatically detect the time and times students practice the piano and the interval between stops, and use the intelligent evaluation system to analyze and evaluate students' performance and performance effect when playing the piano, so as to track and manage students' playing process in real time. In the intelligent management system, teachers can track students' feedback in the learning process in real time and guide students to complete piano learning and practice.

The intelligent piano management system mainly includes the management of teaching information resources and teaching activities. The intelligent piano management system contains a large number of learning resources, which

provide a guarantee for the intelligent piano teaching activities. Teaching resources can not only provide information technology support for teachers to formulate teaching plans and design teaching plans, but also provide learning resources for students' preview, classroom practice, and after-school review. The teaching resource database not only expands the information of traditional piano teaching materials, but also digitizes the music score, teaching materials, and other information resources, so as to provide the retrieval function of resources and information for students and teachers. In addition, the teaching resource library in the intelligent piano management system also includes video, audio, music games, and other resource modules, which provides rich information resources for piano teaching. As shown in Figure 8, it is composed of the teaching information resource library included in the intelligent piano management system.

With the increasing function of artificial intelligence in data collection, analysis, and prediction, the application of artificial intelligence technology in piano teaching can improve the piano learners' practicing efficiency and level. According to the piano course evaluation requirements, the intelligent piano auxiliary teaching system can be developed by using artificial intelligence technology, and then the user's PC terminal can be connected with the cloud service terminal of the intelligent system through the cloud computing center, so as to build an intelligent management service platform for teaching activities [23]. Teachers use this service platform to set up piano course evaluation standards. Through this platform, students can automatically match the played tracks with the evaluation standards, mark the wrong music symbols, and feed back to students in the form of evaluation reports, so as to achieve personalized guidance and targeted evaluation of piano learning. As shown in Figure 9, the intelligent management service platform for teaching activities built through the cloud computing center can not only provide users with teaching information

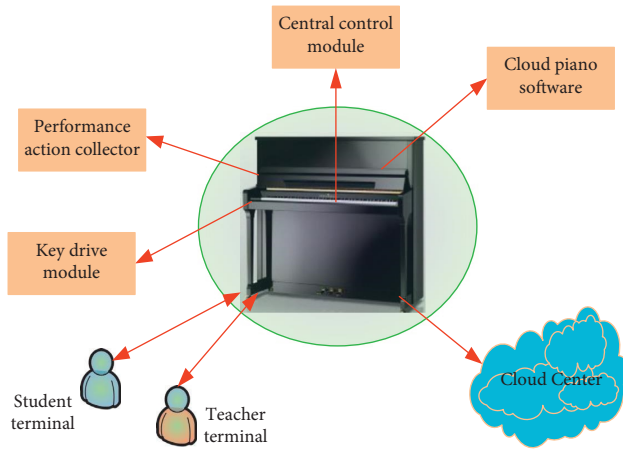


FIGURE 9: Composition and structure diagram of intelligent piano.

resources, but also effectively connect learner terminals and instructor terminals together.

Through the intelligent management service platform of teaching activities, learners can not only timely detect their own playing effects, but also accurately master the learning methods and contents of piano courses. At the same time, teachers can effectively reduce the workload and improve work efficiency through the intelligent management service platform of teaching activities. In addition, the system can also integrate the data of all students' playing results and further systematically analyze the teachers' teaching effectiveness, which not only helps teachers to fully understand the teaching process, but also helps teachers to reflect and improve the teaching content and methods. The analysis and evaluation results of the system can not only provide reference for teachers to further process management and comprehensive evaluation of students, but also stimulate the enthusiasm of piano learners.

4.3. The Influence of Artificial Intelligence on Piano Teaching. Artificial intelligence technology has not only changed the traditional piano teaching mode, but also had a far-reaching impact on piano education to a certain extent. Among them, the objects that artificial intelligence has a greater impact on piano teaching are students and instructors.

In the traditional piano teaching process, students often make some basic mistakes such as wrong pronunciation or are not proficient in the content they have learned. Therefore, teachers often become machines to correct mistakes in class, from imparting knowledge to students' sparring practice, thus affecting the normal teaching progress and effect [13]. Through the intelligent piano teaching service platform, students can automatically detect the music they play during practice. They can not only find their own errors in playing in time, but also use the auxiliary functions of the service platform to solve some conventional errors by themselves. Therefore, by using the auxiliary functions provided by the intelligent piano teaching service platform, students can improve the piano practice efficiency and class quality.

Although the intelligent piano teaching assistant system can bring some help to learners, it may also have some negative effects. Because the intelligent piano teaching system is different from human beings in emotional resonance, if learners rely on the auxiliary functions provided by the intelligent piano teaching system for a long time when practicing, for example, blindly pursuing the score of playing music evaluation when practicing, the music they play will be boring due to the lack of detail processing and music emotion [19]. Therefore, learners should take the intelligent piano teaching system as an auxiliary tool for piano teaching, which cannot be completely replaced by it. Only when the intelligent piano teaching system is organically combined with the teaching process, can the function of the intelligent piano teaching assistant system be brought into play.

In view of the impact of the intelligent piano teaching service system on teachers, compared with the traditional piano teaching mode, the working efficiency of piano teachers has been significantly improved, and the quality of learners' piano practice has also been greatly improved. Although the level of students' piano practice mainly depends on teachers' teaching ability, the traditional piano teaching methods are usually not ideal for learners' piano practice level and learning efficiency. With the help of the intelligent piano teaching service system, teachers' teaching pressure has been relieved, and learners' piano practice level has been significantly improved. For example, learners can use the intelligent piano teaching service system to directly correct some basic problems such as notes and rhythms that often go wrong when practicing the piano. Teachers can use more time to pay attention to the processing of music details and the expression of music emotions when students are in class.

Although the intelligent piano teaching system alleviates the teaching burden of teachers to a great extent, artificial intelligence brings new pressure to piano teachers. Using the traditional piano teaching mode, teachers can often carry out teaching discussion, teaching experience exchange, and other activities, and continuously improve their teaching level by learning some successful teaching methods. However, after adopting the intelligent piano teaching mode, teachers can only continuously improve their teaching ability and teaching quality to meet the requirements of modern teaching design and the various needs of learners. At the same time, through the teaching resources provided by the intelligent piano teaching service platform, they can continuously integrate their own teaching ability, so as to continuously improve their teaching level. With the continuous development of artificial intelligence technology and other related technologies, in the future piano teaching, teachers should constantly adapt to the changes of the new teaching mode.

5. Analysis and Evaluation of Teaching Effect

In order to test the feasibility and effectiveness of the piano teaching model based on machine learning and artificial intelligence in practical teaching application, two different classes were randomly selected from some piano learners as

TABLE 1: Comparison of piano teaching effect between two groups of learners.

Item	Theoretical knowledge test	Hand test	Key touch mode test	Spectrum identification test	Rhythm control test
Control group	83.5	85.1	85.2	84.7	81.3
Experimental group	87.4	86.4	92.6	91.5	88.6
<i>P</i>	>0.05	>0.05	<0.05	<0.05	<0.05

TABLE 2: Comparison of evaluation results of the impact of piano teaching mode on learners.

Item	Practice enthusiasm	Playing emotion	Learning effect
Control group	19.26 ± 2.13	38.24 ± 3.35	84.37 ± 7.25
Experimental group	23.41 ± 2.59	42.46 ± 3.85	90.36 ± 7.38
<i>T</i>	2.215	2.362	3.583
<i>P</i>	<0.05	<0.05	<0.05

experimental teaching objects. According to the existing piano teaching plan, under the condition of not affecting students' normal piano practice, random tests were conducted on the learners, and the learners with no significant difference between the two classes were taken as the experimental group and the control group, respectively. Suppose class 1 is the control group and class 2 is the experimental group, with 20 students in each class. The control group used the traditional piano teaching mode, and the experimental group used the intelligent piano teaching mode. Through the piano teaching experiment, under the same examination method, content, and evaluation standard, the students' piano theoretical knowledge and playing effect of the two classes were tested.

5.1. Piano Teaching Effect Test. From the comparison of the assessment results of piano theoretical knowledge, it was known that the two groups of students had better ability to master piano theoretical knowledge. The average score of the control group was 83.5, and the average score of the experimental group was 87.4. After examination and test, there was no significant difference between the two groups. From the comparison of the results of piano hand type test, it was found that although different piano teaching modes had certain effects on learners' hand type, there was no significant difference between the two groups. However, from the comparison results of the piano touch mode, spectrum recognition, and rhythm control ability test results, the average scores of the students in the experimental group were 92.6, 91.5, and 88.6, respectively, and the average scores were higher than those in the control group. After examination and test, there was a certain significant difference between the two groups. It can be seen that the piano teaching mode proposed in this paper mainly focused on the learning of piano key touching mode and optimized the ability of spectrum recognition and rhythm control, so that learners can participate in the whole process of piano teaching in real time. Therefore, when learners improved their ability to master the details of piano practice and emotions to a certain extent, they will soon be recognized by everyone. The self-confidence gained in the process of piano

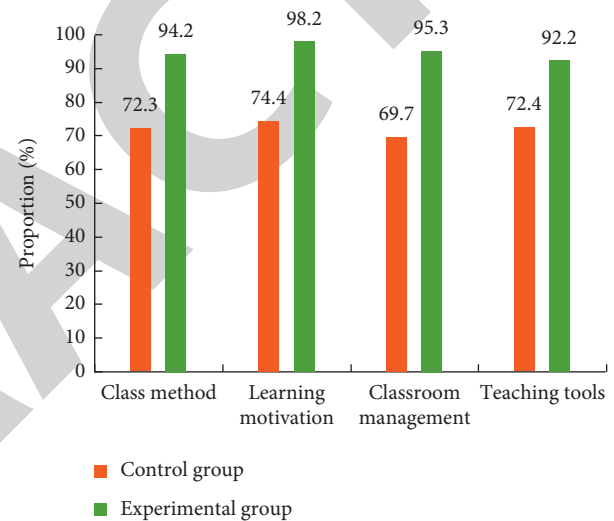


FIGURE 10: Comparison of the proportion of the two groups who rated piano teaching mode as good.

practice had also improved the enthusiasm of learners in training, and the teaching effect had been significantly improved. The comparison results of piano teaching effects between the two groups are shown in Table 1.

5.2. Evaluation and Comparison of Piano Teaching Mode by Piano Practitioners. In order to facilitate the research object to objectively evaluate the intelligent piano teaching mode proposed in this paper, this experiment uses the form of questionnaire and interview to investigate the impact of the intelligent piano teaching mode on the experimenter. Among them, it mainly evaluates the students' performance from three aspects: learning enthusiasm, emotion of practicing piano, and learning effect. All evaluation indexes are expressed by mean and standard deviation, and the later data are processed by statistical software. From the score results of the experimental group in various items, the scores of the experimental group are about 5 points higher than those of the control group, especially in terms of learning effect. Therefore, the evaluation results of students in the

experimental group in practice enthusiasm, game emotion, learning effect, and so on are significantly higher than those in the control group, as shown in Table 2. It can be seen that the intelligent piano teaching mode proposed in this paper can effectively stimulate the students' enthusiasm to practice the piano, give full play to the students' personality, meet the actual needs of piano lovers to a certain extent, and enhance the learners' learning motivation.

According to the statistical results of the questionnaire survey conducted by each group on the evaluation of different piano teaching modes, the students in the experimental group evaluated the teaching methods, learning enthusiasm, and other indicators above the good level, as shown in Figure 10. Therefore, students are generally satisfied with the intelligent piano teaching mode proposed in this paper.

6. Conclusion

Artificial intelligence accelerated the development of music education to a certain extent and changed the traditional piano teaching mode. However, there were many problems in the integration of artificial intelligence with other technologies, which affected the application of artificial intelligence in piano teaching. In order to effectively improve the quality of piano teaching, this paper proposed a piano teaching model based on machine learning and artificial intelligence. By analyzing the relevant theory of machine learning and its application characteristics to music teaching, this paper put forward the auxiliary method of intelligent piano teaching, constructed an intelligent piano teaching service management system, and analyzed the various effects of artificial intelligence on piano teaching. Finally, taking piano learners under different teaching modes as the object, this paper made an investigation and analysis from the aspects of piano teaching effect and the evaluation of piano practitioners on the teaching mode. According to the results of statistics and comparison, the piano teaching mode proposed in this paper had achieved better results in theoretical teaching and practical operation than the traditional teaching mode, which was conducive to promoting the quality of piano teaching and the enthusiasm of learners. This study can provide a reference for the further development of intelligent piano teaching application.

Data Availability

The labeled data set used to support the findings of this study is available from the author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

Acknowledgments

This work was supported by the Sports Department of Cangzhou Normal University.

References

- [1] M. C. Liu and J. R. Huang, "Piano playing teaching system based on artificial intelligence - design and research," *Journal of Intelligent and Fuzzy Systems*, vol. 40, no. 2, pp. 3525–3533, 2021.
- [2] L. Yan, "Design of piano teaching system based on internet of things technology," *Journal of Intelligent and Fuzzy Systems*, vol. 37, no. 5, pp. 5905–5913, 2019.
- [3] M. Sobel, "Teaching resonance and harmonics with guitar and Piano¹," *The Physics Teacher*, vol. 52, no. 2, pp. 80–82, 2014.
- [4] L. Yang, "Reform of piano teaching methods in the internet environment," *Basic and Clinical Pharmacology and Toxicology*, vol. 124, p. 152, 2019.
- [5] C. Shuo and C. Xiao, "The construction of internet + piano intelligent network teaching system model," *Journal of Intelligent and Fuzzy Systems*, vol. 37, no. 5, pp. 5819–5827, 2019.
- [6] Y. J. Chen and N. Zheng, "AI based research on exploration and innovation of development direction of piano performance teaching in university," *Journal of Intelligent and Fuzzy Systems*, vol. 40, no. 2, pp. 3681–3687, 2021.
- [7] X. X. Xue, "Reform of the piano teaching methods in the internet environment," *Basic and Clinical Pharmacology and Toxicology*, vol. 126, pp. 97–98, 2020.
- [8] T. Hagendorff, "Linking human and machine behavior: a new approach to evaluate training data quality for beneficial machine learning," *Minds and Machines*, vol. 31, no. 4, pp. 563–593, 2021.
- [9] X. Luo, X. N. Yang, C. W. Jiang, and X. J. Ban, "Timeliness online regularized extreme learning machine," *International Journal of Machine Learning and Cybernetics*, vol. 9, no. 3, pp. 465–476, 2018.
- [10] E. Weinan, "Machine learning and computational mathematics," *Communications in Computational Physics*, vol. 28, no. 5, pp. 1639–1670, 2020.
- [11] Y. Xia, "Resource scheduling for piano teaching system of internet of things based on mobile edge computing," *Computer Communications*, vol. 158, pp. 73–84, 2020.
- [12] J. Fan, "Research on piano education from the perspective of music eco-environment psychology," *Ekoloji*, vol. 28, no. 107, pp. 3281–3289, 2019.
- [13] Y. F. Kao and R. Venkatachalam, "Human and machine learning," *Computational Economics*, vol. 57, no. 3, pp. 889–909, 2021.
- [14] H. Chase and J. Freitag, "Model theory and machine learning," *The Bulletin of Symbolic Logic*, vol. 25, no. 03, pp. 319–332, 2019.
- [15] S. Li, S. J. Song, and Y. H. Wan, "Laplacian twin extreme learning machine for semi-supervised classification," *Neurocomputing*, vol. 321, pp. 17–27, 2018.
- [16] T. M. Khan and A. Robles-Kelly, "Machine learning: quantum vs classical," *IEEE Access*, vol. 8, pp. 219275–219294, 2020.
- [17] L. Chen, "Development of the indoor piano performance training in the piano teaching design of colleges and universities," *Basic and Clinical Pharmacology and Toxicology*, vol. 125, p. 208, 2019.
- [18] X. X. Zhai, "The positive role of the mixed mode of piano teaching in colleges and universities in improving students' psychological development under educational psychology," *Psychiatria Danubina*, vol. 34, pp. S880–S881, 2022.
- [19] H. Al-Sahaf, Y. Bi, Q. Chen et al., "A survey on evolutionary machine learning," *Journal of the Royal Society of New Zealand*, vol. 49, no. 2, pp. 205–228, 2019.

Retraction

Retracted: Image Processing Based on Fuzzy Mathematics Theory

Security and Communication Networks

Received 19 September 2023; Accepted 19 September 2023; Published 20 September 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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] M. Hou, "Image Processing Based on Fuzzy Mathematics Theory," *Security and Communication Networks*, vol. 2022, Article ID 5287025, 10 pages, 2022.

Research Article

Image Processing Based on Fuzzy Mathematics Theory

Maowen Hou 

School of Mathematics and Computer Science, Tongling University, Tongling 244061, Anhui, China

Correspondence should be addressed to Maowen Hou; hmw@tlu.edu.cn

Received 16 June 2022; Revised 15 July 2022; Accepted 30 July 2022; Published 22 August 2022

Academic Editor: Tao Cui

Copyright © 2022 Maowen Hou. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

In order to further improve the problems of poor rationality and weak antinoise ability of existing image processing algorithms and technical algorithms, an image processing research method based on fuzzy mathematical theory is proposed. First, aiming at the ill-posed problem of the PFCM algorithm, the neutrality and rejection degree are used to construct a regular term and embed the algorithm objective function to enhance the correlation between the attribute parameters of the fuzzy set of the sample graph, so as to solve the ill-posed problem of the PFCM algorithm. Secondly, in view of the same noise sensitivity problem of PFCM algorithm as a traditional fuzzy clustering algorithm, combined with the robust ideas of FCM_S1 and FCM_S2 algorithms, the objective function of robust segmentation algorithm for graph fuzzy clustering (RPFCM_s) is constructed. The misclassification rate of the clustering algorithm proposed in this study in image segmentation is reduced by 38%–76%, and the misclassification rate of the corresponding segmentation result of the ATPFCA algorithm is reduced by 5%–77%. Therefore, the algorithm not only improves the effective segmentation efficiency of the fuzzy mathematical theory algorithm for the processing of uneven grayscale images but also enhances the anti-noise robustness of the algorithm.

1. Introduction

Since it was put forward in 1965, fuzzy mathematics theory has played a key role in studying and dealing with fuzzy phenomena. The basic concept of fuzzy mathematics theory is a fuzzy set. In recent years, scholars have deepened their research on fuzzy mathematics theory, and fuzzy mathematics theory has been widely used in many industries and fields. Specifically, fuzzy mathematics theory accurately defines fuzzy phenomena through the in-depth analysis and research method application of fuzzy phenomena. In fact, there are many fuzzy phenomena in our work and life. The help of fuzzy mathematics theory can help us analyze and solve these problems. Computer image processing technology is to better recognize and calculate the image with the help of computer technology. The purpose of the integration of the two is to further improve the accuracy and accuracy of image processing [1]. Figure 1 shows an image fusion method based on fuzzy mathematics theory.

2. Literature Review

Image segmentation is an important pre-processing step of pattern recognition, machine vision, image understanding, and analysis. After decades of research, it still receives wide attention from many scholars [2]. There are currently many methods for image segmentation, which can be broadly divided into four types: threshold-based segmentation methods, edge detection-based segmentation methods, region-based segmentation methods, and theory-based segmentation methods. In recent 10 years, with the proposal of new theories in various disciplines, image segmentation algorithms based on these theories are also emerging, and the theoretical system of image segmentation algorithms is being further developed. The image segmentation algorithm based on edge detection will focus on the edge part of the image. The boundaries between different homogeneous regions in the image have unique properties, and the gray value will jump along the direction perpendicular to the edge. Using this characteristic, the jumping pixel points in

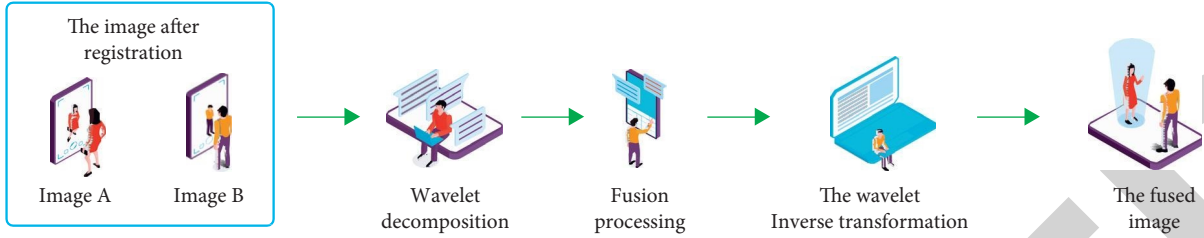


FIGURE 1: An image fusion method based on fuzzy mathematics theory.

the image to be segmented can be detected, and the set of these points is the boundary to distinguish different homogeneous targets and backgrounds. The method of edge detection is to use the difference operator of gray mutation in the pixel neighborhood and the change of the first or second derivative of the edge to judge whether the sample points are boundary pixels and finally realize image segmentation. The theoretical system of image segmentation algorithms is being further developed. Classical edge detection operators include the Roberts operator, Prewitt operator, Sobel operator, Laplacian operator, Canny operator, and so on. Since this kind of algorithm is based on the principle of gray value jump in pixel neighborhood, this kind of algorithm is more sensitive to noise, especially the second derivative. Therefore, for noisy images, false edges may appear, resulting in unreasonable boundary contour. If the noise resistance of the algorithm is improved, the actual edge area will be weakened, resulting in edge missing detection. In both cases, the detected edge will deviate from the actual edge, resulting in unreasonable segmentation results [3–5].

For the image itself, the pixels in the same region have the same or similar features, the feature distribution in different regions is inconsistent, and the pixel features between different regions are abrupt and uncertain. At the same time, the influence of some external factors on the drawing process also affects the drawing, such as angle of view, illumination, shadow, spatial position, and so on, the target area and background area have a certain similarity, and the boundary between the target and background is uncertain. These pseudo similarity and uncertainty can be called fuzziness, which makes image segmentation become a typical ill-structured problem, resulting in that most clustering segmentation methods are only suitable for one or several types of image segmentation [6]. In order to obtain more satisfactory segmentation results and make full use of the uncertainty and fuzziness of image pixels, fuzzy clustering was once pushed to the forefront of the research of image clustering and segmentation algorithm, the use of dim cluster technology to address image segmentation is a new trend and is also one of the hot topics in the image segmentation industry.

Based on this research, this study proposes image processing research based on fuzzy mathematical theory. By closely correlating neutrality and rejection degree, the correlation between various attribute parameters is improved, and the misclassification and misclassification of the original graph fuzzy clustering algorithm due to ill-posed problems are solved. According to the

characteristics of the proposed algorithm's objective function, the convergence of the algorithm is deduced and proved by the idea of divide and conquer, and the convergence of the algorithm's objective function is verified by using standard grayscale images and noise interference images. The test results show that the improved algorithm RPFM has faster convergence performance than FCM, IFCM, FC-PFS and PFCM, and other algorithms; the RPFM algorithm has better segmentation performance than the existing PFCM algorithm.

3. 3D Model Construction Based on Image Processing

In recent decades, the problem of restoring structure 3D models from multiple two-dimensional plane images has been widely and deeply studied. In particular, the 3D scene structure can be restored and reconstructed (structure from motion, SFM) during camera movement, so that feature points can be detected from uncalibrated images or image sequences, feature point matching can be performed, and the 3D structure model of the scene can be established. The basic idea is shown in Figure 2.

In machine learning and image processing, data is usually represented as vectors. The complexity of many machine learning algorithms is exponentially related to the dimensional nature of the data. The larger the dimension, the greater the complexity of data processing and the more time it takes. In order to reduce time consumption and avoid the waste of machine resources, data dimensionality must be reduced. Dimensionality reduction of data means the loss of data, but the actual data are often related. On this basis, the loss of data can be reduced during dimensionality reduction. Basic Component Analysis (PCA) is a widely used method of reducing the size of data based on solid data. The main idea of PCA is to reduce the n -dimensional nature of the data to k -scale ($k < n$). In this way, the purpose of data reduction and feature extraction is realized [7–9]. The specific process of the PCA algorithm is as follows: suppose there is a data set S , including m samples, and the dimension of each sample is n , that is:

$$S = (x_1, x_2, x_3, x_4, \dots, x_m), \quad (1)$$

$$x_i = (x_{i1}, x_{i2}, x_{i3}, x_{i4}, \dots, x_{im}).$$

The data set S is represented in the form of a matrix, and then each row of the matrix is a sample, and each column is a dimension, that is:

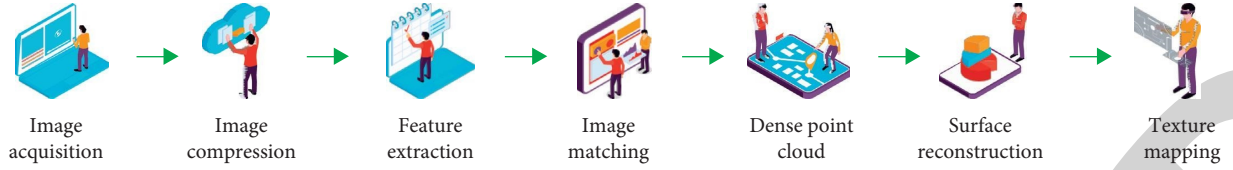


FIGURE 2: Flow chart of image-based 3D reconstruction method.

$$S \in R^{m \times n}. \quad (2)$$

Zero the average value of each row of S , that is, subtract the average value of this row:

$$\begin{aligned} \tilde{x}_i &= x_i - \bar{x}, \\ \bar{x} &= \frac{1}{m} \sum_{i=1}^m x_i. \end{aligned} \quad (3)$$

The matrix consisting of \tilde{x}_i is recorded as:

$$\tilde{S} \in R^{m \times n}. \quad (4)$$

Then calculate the covariance matrix C of matrix \tilde{S} :

$$\begin{aligned} C &= \frac{1}{m} \tilde{S}^T \tilde{S} \\ &= \frac{1}{m} \sum_i^m \tilde{x}_i^T \tilde{x}_i, \end{aligned} \quad (5)$$

where $C \in R^{m \times n}$ calculate the eigenvalues of the covariance matrix C and the corresponding eigenvectors, place the eigenvectors as a matrix from top to bottom according to their respective eigenvalues, and take the first k -line to form a P -matrix. PCA matrix. Then, after reducing the size, the matrix is:

$$\tilde{s} = \tilde{s}p. \quad (6)$$

In summary, PCA, by its very nature, takes the direction of greatest variability and “correlates” the data in each orthogonal direction, i.e., independent of the different orthogonal directions, and can be used well for image compression according to PCA characteristics.

In order to apply the PCA algorithm to 3D model reconstruction and process images faster and better, it is necessary to deform the PCA algorithm or segment large-resolution images [10]. From the singular value decomposition, the PCA algorithm is a variant of the singular value decomposition algorithm (SVD). The singular value decomposition algorithm can decompose any matrix. The formula is as follows:

$$A = U \sum V^T. \quad (7)$$

A is an $m \times n$ matrix, U is an $m \times m$ matrix, V is an $n \times n$ matrix, and \sum is an $m \times n$ matrix. Where u and V are the left singular vector and right singular vector of A , respectively, and \sum is the singular value of A . Multiply both ends of the equal sign of formula (7) by U^T to obtain:

$$U^T A = U^T U \sum V^T. \quad (8)$$

According to the above requirements and steps of algorithm time, we use the PCA algorithm to compress the concrete test block. The resolution of the image of the test block is 768×1024 . The flow of compression processing is as follows.

Step 1. Decompose the image into n sub-images, and the size of each sub-image is K . With the different value of K , the number n of sub-images changes accordingly. In the compression experiment, the K value is arranged from small to large, and the values are $K=2$, $K=3$ and $K=4$, respectively. The number of corresponding sub-images n is: $N=196608$, $N=87495$, $N=49216$

Step 2. Calculate the average value of N sub-images:

$$\overline{\text{IMG}} = \frac{\text{IMG}_1 + \text{IMG}_2 + \dots + \text{IMG}_N}{N}. \quad (9)$$

The above formula represents the average of N sub-images, then subtracts the average of the images from these N sub-images and takes N new sub-images.

Step 3. Calculate the covariance matrix R of the new sub-image, which is defined as:

$$R(i, j, t, l) = \frac{1}{N} \sum_{S=1}^N \text{IMG}_S(i, j) \text{IMG}_S(t, l). \quad (10)$$

In the above formula, i, j, t, l , respectively, represent the positions of elements in the image.

Step 4. Calculate the eigenvalue and eigenvector of R , and calculate the inner product and maximum eigenvector of each sub-image to obtain the compressed image [11, 12].

In order to further verify that the image compression will not affect the image modeling effect, it is necessary to scale the model. And it is compared with the conversion results of the original picture model. After the dense point cloud reconstruction, the reconstructed model is scaled according to the actual size of the shear wall structure to obtain the transformation relationship. After reconstruction, verify the size of the model through the pre-calibration points on the shear wall. In order to further prove the feasibility and applicability of the algorithm in practical engineering, this chapter selects a rainbow bridge as an engineering example for modeling. The original Rainbow Bridge image modeling time is 118398.108 s, about 32 hours, 53 minutes, and 18 seconds. The modeling time of the picture compressed by the

PCA algorithm is 41057.931 s, about 11 hours, 23 minutes, and 17 seconds. In order to make the comparison result more intuitive, this example only intercepts the picture of the rainbow bridge model and does not add the reconstructed useless information to the comparison. It can be seen from the time comparison that this method is still applicable when the target is a large structure, which can greatly reduce the modeling time [13, 14].

4. Graph Fuzzy Clustering and Robust Segmentation Algorithm

4.1. *Regularized Graph Fuzzy Clustering Algorithm.* The objective function of the graph fuzzy clustering (PFCM) algorithm can be described as:

$$\min J_m(\mu, \eta, \xi, V) = \sum_{k=1}^c \sum_{i=1}^n (\mu_{ik}(2 - \xi_{ik}))^m \|x_i - v_k\|^2 + \sum_{k=1}^c \sum_{i=1}^n \eta_{ik}(\log_{\eta_{ik}} + \xi_{ik}). \quad (11)$$

The expression of the optimization objective function corresponding to the improved graph fuzzy clustering algorithm is:

$$\min J_m(\mu, \eta, \xi, V) = \sum_{k=1}^c \sum_{i=1}^n \left(\frac{\mu_{ik}}{1 - \eta_{ik} - \xi_{ik}} \right)^m \|x_i - v_k\|^2 + \sum_{k=1}^c \sum_{i=1}^n \eta_{ik}^2 \xi_{ik} + \eta_{ik} \xi_{ik}^2. \quad (12)$$

The constraints are as follows:

$$\begin{aligned} 0 \leq \mu_{ik}, \xi_{ik}, \eta_{ik} \leq 1, 0 \leq \mu_{ik} + \xi_{ik} + \eta_{ik} \leq 1, \quad i = 1, 2, \dots, n, k = 1, 2, \dots, c, \\ \sum_{k=1}^c \frac{\mu_{ik}}{1 - \eta_{ik} - \xi_{ik}} = 1, \quad i = 1, 2, \dots, n, \\ \sum_{k=1}^c \left(\eta_{ik} - \frac{1}{c} \xi_{ik} \right) = 1, \quad i = 1, 2, \dots, n, \end{aligned} \quad (13)$$

where n represents the number of clustering samples; c represents the number of cluster categories; μ_{ik} , η_{ik} , ξ_{ik} represent the membership degree, neutrality degree, and rejection degree of the i th sample belonging to class k ,

respectively; v_k represents the clustering center of class k ; m represents the fuzzy index.

The objective function of unconstrained optimization is obtained by the Lagrange multiplier method, and its expression is:

$$\begin{aligned} L = \sum_{k=1}^c \sum_{i=1}^n \left(\frac{\mu_{ik}}{1 - \eta_{ik} - \xi_{ik}} \right)^m \|x_i - v_k\|^2 + \sum_{k=1}^c \sum_{i=1}^n (\eta_{ik}^2 \xi_{ik} + \eta_{ik} \xi_{ik}^2) \\ + \sum_{i=1}^n \lambda_i \left(1 - \sum_{k=1}^c \frac{\mu_{ik}}{1 - \eta_{ik} - \xi_{ik}} \right)^m + \sum_{i=1}^n \beta_i \left(1 - \sum_{k=1}^c \left(\eta_{ik} + \frac{1}{c} \xi_{ik} \right) \right). \end{aligned} \quad (14)$$

The expression of the rejection index can be obtained by using the Yager complement operator (combined with constraints) as follows:

$$\xi_{ik} = 1 - (\mu_{ik} + \eta_{ik}) - (1 - (\mu_{ik} + \eta_{ik})^\alpha)^{(1/\alpha)}. \quad (15)$$

4.2. Experimental Simulation and Result Analysis. In order to verify the effectiveness and anti-noise of the improved regularized graph fuzzy clustering robust segmentation algorithm, the segmentation tests are carried out on different images and images with different intensity types of noise. In order to arrange the layout neatly, images of different sizes are displayed as the same size, and the layout of other chapters is also the same. The test running environment is Matlab 2014a. Set the test parameter fuzzy index $m = 2.0$, iteration termination error $\varepsilon = 1 \times 10^{-4}$, and maximum iteration times $t_{\max} = 10^3$.

4.2.1. Segmentation Test and Result Analysis of Noise-Free Image. Three gray images of brain CT image, coin image, and water cup image with the size of 256×256 are selected. FCM algorithm, IFCM algorithm, FC-PFS algorithm, PFCM algorithm, PRFCM algorithm, and RPFCM_s algorithm are used for the segmentation test, respectively. The corresponding error rates as a result of the segmentation of the various algorithms are shown in Table 1.

From the above results, the segmentation results obtained by the FCM algorithm, IFCM algorithm, FC-PFS algorithm, and RPFCM algorithm cannot store image details, but only a rough outline of the image can be obtained, but the PFCM algorithm can store image details but image sound contains noisy dots. From the incorrect classification of the results of the segmentation of the six algorithms shown in Table 1, it can be seen that the level of incorrect classification of the PRFCM_s algorithm is lower than that of the other five algorithms. The results of brain CT and water cup map were particularly obvious, and the misclassification rate decreased by 0.42%~25.66%; For the more complex water cup graph, the misclassification rate of the PRFCM_s algorithm is also reduced. Therefore, in contrast, the regularized graph fuzzy clustering robust segmentation algorithm has certain segmentation advantages [15, 16].

4.2.2. Segmentation Test and Result Analysis of Gaussian Noise Interference Image. The 256×256 brain CT images, gear images, and photographer images were selected as the raw image data for the anti-Gaussian noise performance test of the RPFCM_s algorithm. Using the FCM algorithm, the IFCM algorithm, the FC-PFS algorithm, the PFCM, and the PFCM algorithm, add the Gaussian noise with an average value of 0, the variance 57, 81, 81 (normalized variance of 0.05, 0.1, and 0.1) on the three images. The RPFCM_s algorithms are used for segmentation experiments, and the values of the peak signal-to-noise ratios corresponding to the segmentation results obtained by different algorithms are shown in Table 2.

Out of the segmentation results obtained by the six segmentation algorithms, the segmentation results obtained by the FCM algorithm, IFCM algorithm, FC-PFS algorithm, PFCM algorithm, and RPFCM algorithm all contain more noisy points, and the details are blurred; Contains the results of segmentation obtained by the RPFCM_s algorithm. The number of noise points is relatively rare, and the segmentation effect is better than the other five algorithms. The peak

signal and noise ratios of the anti-Gaussian noise shown in Table 2 show that the FCM, IFCM, FC-PFS, PFCM, and RPFCM algorithms are not significantly different as a result of segmentation, but the peak signal-to-noise ratio is a segmentation of the RPFCM_s algorithm. agrees. The value of the noise ratio is much larger than the first five algorithms. The improved algorithm of RPFCM_s shows that it is strong against Gaussian noise interference [17].

4.2.3. Segmental Testing and Analysis of the Results of Salt and Pepper Noise Interference. The RPFCM_s algorithm selected a 256×256 square shape, a gear shape, and a pepper shape as the initial drawing data for the salt and pepper anti-noise performance test. The three images were added with a salt and pepper noise of 0.2 probability, and the FCM algorithm, IFCM algorithm, FC-PFS algorithm, PFCM algorithm, RPFCM, and RPFCM_s algorithms were used for segmentation testing. The values of the ratios obtained as a result of the segmentation obtained by the various algorithms are shown in Table 3.

From the results of the above segmentation, it can be seen that the segmentation results of the three images obtained by the RPFCM_s algorithm are more detailed and complete, with only a small amount of noise, while the segmentation results obtained by the other five algorithms are blurred. and a lot of noise. In addition, the peak signal-to-noise ratios of the six algorithms shown in Table 3 are significantly higher than the values of the corresponding peak-to-noise ratios obtained by the RPFCM_s enhanced algorithm. from the peak signal-to-noise ratio corresponding to the other five algorithms. Therefore, the RPFCM_s algorithm has a strong ability to resist salt and pepper noise [18].

4.2.4. Segmentation Test and Result Analysis of Mixed Noise Interference Image. The cell image, pepper image, and gear image with the size of 256×256 were selected as RPFCM_s algorithm anti mixed noise performance test of the original image data. Add Gaussian noise with the mean value of 0, the variance of 0.05, and salt and pepper noise with a probability of 0.1 to the cell diagram and pepper diagram, add Gaussian noise with the mean value of 0, the variance of 0.1, and salt and pepper noise with the probability of 0.1 to the gear diagram, and use FCM algorithm, IFCM algorithm, fc-pfs algorithm, PFCM algorithm, rpfcm and rpfcm_S algorithm for segmentation test. The peak signal-to-noise ratio corresponding to the segmentation results obtained by different algorithms is shown in Table 4.

From the results obtained by the six segmentation algorithms, the segmentation results obtained by the FCM algorithm, the IFCM algorithm, the FC-PFS algorithm, the PFCM algorithm, and the RPFCM algorithm all contain a large number of noise points. Reduced and more detailed. Compared to the other five algorithms, the RPFCM_s algorithm has better segmentation performance. In addition, the peak values of the signal-to-noise ratios corresponding to the segmentation results of each algorithm shown in Table 4 can be seen. The RPFCM_s algorithm is much larger than

TABLE 1: Error rate corresponding to segmentation results of different algorithms (unit: %).

Image	FCM algorithm	IFCM algorithm	FC-PFS algorithm	PFCM algorithm	PRFCM algorithm	PFCM_S algorithm
Brain CT image	13.57	15.85	13.57	2.76	13.57	2.34
Coin image	5.01	6.54	5.01	5.33	5.01	3.71
Cup image	18.61	26.31	18.61	12.46	18.61	1.64

TABLE 2: Peak signal-to-noise ratio of segmentation results of different algorithms (unit: dB).

Noisy image	FCM algorithm	IFCM algorithm	FC-PFS algorithm	PFCM algorithm	PRFCM algorithm	PFCM_s algorithm
Brain CT image	10.3371	8.3440	10.3706	10.6576	10.2634	17.3565
Gear image	9.0641	9.0851	9.1087	9.0061	9.0380	16.1811
Photographer image	5.2004	5.2466	5.2403	5.1053	5.2363	9.5621

TABLE 3: Peak signal-to-noise ratio of segmentation results of different algorithms (unit: dB).

Noisy image	FCM algorithm	IFCM algorithm	FC-PFS algorithm	PFCM algorithm	PRFCM algorithm	PFCM_s algorithm
Block image	10.0007	9.7353	10.0172	8.7658	9.8760	19.0008
Gear image	9.7376	9.8761	9.7723	9.6867	9.8230	17.7851
Pepper image	9.0285	9.0430	9.0387	9.0055	9.0350	11.6010

TABLE 4: Peak signal-to-noise ratio of segmentation results of different algorithms (unit: dB).

Noisy image	FCM algorithm	IFCM algorithm	FC-PFS algorithm	PFCM algorithm	PRFCM algorithm	PFCM_s algorithm
Cell image	5.8425	5.6187	5.7260	5.6721	5.7521	13.3024
Pepper image	5.6821	5.6625	5.6536	5.6655	5.6705	12.3366
Gear image	6.8876	9.7536	7.0003	6.7241	7.0003	14.5505

the other five algorithms, which effectively demonstrates that RPF_{CM_s} has a strong resistance to mixed noise interference. Add neighborhood means information to traditional FCM algorithm, IFCM algorithm, FC-PFS algorithm, and PFCM algorithm, respectively, to obtain FCM_s algorithm, IFCM_s algorithm, FC-PFS_s, and FC-PFS_s algorithm is combined with the idea of fuzzy c-means robust clustering algorithm to obtain FC-PFS_s algorithm and FC-PFS_s algorithm. Test the robustness of different gray images and compare them with the PRFCM_s algorithm [19].

4.2.5. Test and Analysis of Robust Segmentation of Image Disturbed by Gaussian Noise. A basketball court remote sensing image, a river remote sensing image, and a 256×256 brain CT image were selected, with a mean value of 0 and a variance of 44, 81, and 81 (normalized variance 0.03, 0.1, and 0.1, respectively) of Gaussian noise. The results of the segmentation experiment are shown in Table 5.

From the above results, the IFCM_s algorithm has the worst segmentation result and serious noise point pollution. Among them, the segmentation result of brain CT image shows that the IFCM_s algorithm blurs the details; FCM_s algorithm, FC-PFS_s algorithm, and PFCM_s algorithm have the same segmentation results; and the segmentation results obtained by the PRFCM_s algorithm are much better than the IFCM_s algorithm and better than the other three algorithms. From the values of the peak signal-to-noise ratios corresponding to the five segmentation algorithms

shown in Table 5, the values of the peak signal-to-noise ratios corresponding to the segmentation results of the IFCM_s algorithm are the lowest; As a result of the segmentation of the FC-PFS_s algorithm, the values of the corresponding peak signal and noise ratios are compared. The FCM_s algorithm is slightly larger; As a result of the segmentation of the PFCM_s algorithm, the values of the corresponding peak signal-noise ratios are those of the FCM_s algorithm and the FC-PFS_s algorithm; As a result of the segmentation of the PRFCM_s algorithm, the value of the corresponding peak signal-to-noise ratio is relatively high, indicating that the improved RPF_{CM_s} algorithm performs better noise interference [20].

4.2.6. Test and Analysis of Robust Segmentation of Salt and Pepper Noise Interference Image. Three images of the Chinese character Shu map, river remote sensing map, and photographer map with the size of 256×256 are selected to segment salt and pepper noise with the additional probability of 0.1, 0.15, and 0.15, respectively. The results are shown in Table 6.

From the peak values of the signal-to-noise ratio corresponding to the six segmentation algorithms shown in Table 6, it can be seen that the peak signal-to-noise ratio of the RPF_{CM_s} enhanced algorithm is much higher than that of the IFCM_s and PFCM_s algorithms, FCM_s and FC-PFS_s, which further shows that PRFCM_s algorithm has strong anti-salt and pepper noise interference ability.

TABLE 5: Peak signal-to-noise ratio of segmentation results of different algorithms (unit: dB).

Noisy image	FCM_s	IFCM_s	FC-PFS_s	PFCM_s	PFCM_s algorithm
Remote sensing map of basketball court	17.7437	7.2047	17.7843	17.0811	18.2856
River remote sensing map	14.5630	7.3170	14.6632	14.1162	14.6283
Brain CT	15.6738	10.7040	14.6663	14.8166	16.3224

TABLE 6: Peak signal-to-noise ratio of segmentation results of different algorithms (unit: dB).

Noisy image	FCM_s	IFCM_s	FC-PFS_s	PFCM_s	PFCM_s algorithm
Han Zishu	13.0804	9.0026	13.0005	11.8381	13.7060
River remote sensing map	16.7610	8.2306	17.8418	14.8110	18.5745
Photographer	11.8502	8.7006	13.0820	11.7160	13.2305

4.2.7. *Test and Analysis of Robust Image Segmentation with Mixed Noise Interference.* Three grayscale images of a river remote sensing map, a Chinese character and a block map with the size of 256×256 are selected. Add 0 averages for remote sensing maps and Chinese characters, Gaussian noise with 57 variances (normalized variance 0.05), salt and pepper noise with a probability of 0.1, and add an average of 0 to the variable block map. 72 (0.08 normalized variance) Gaussian noise and salt and pepper noise with a probability of 0.1, the results are shown in Table 7.

For remote sensing image and Chinese character space image, IFCM_s algorithm has the worst segmentation results, and there is little difference among FCM_s algorithm, FC-PFS_s algorithm, PFCM_s algorithm and improved algorithm PRFCM_s; For the block diagram, the segmentation results of the five algorithms are equivalent. As a result of the segmentation shown in Table 7, the peak signal-to-noise ratio of the corresponding PFCM_s algorithm shows that the peak signal-to-noise ratio is higher than the other four algorithms. The improved algorithm has a relatively strong ability to counteract mixed noise interference. To test the integrity of the enhanced RPFCA algorithm, select a barrel map (size 215×300) and a photographer map (size 256×256) and add Gaussian noise, salt and pepper noise, Gaussian and salt and pepper mixed noise, respectively. The PRFCM algorithm is used for clustering and segmentation test. In order to better observe the convergence curve of the algorithm, the parameters α and ω are 0.38 and 2 respectively. The results are shown in Figure 3.

As shown in Figure 3(a)–3(d), the clustering objective function obtained by the regularized graph fuzzy clustering algorithm for segmenting the original image and the image interfered by Gaussian, salt and pepper and mixed noise decreases monotonically and tends to be stable with the change of iteration times T . Indicating that the clustering model is reasonable and the algorithm is convergent.

In order to study the convergence speed of PRFCM algorithm, FCM, IFCM, FC-PFS, PFCM, PRFCM, and PRFCM_s algorithms are used to test the convergence of rice grain map (size 256×256), photographer map (size 256×256), river remote sensing map (size 306×342) and wheel map (size 232×205). The number of convergence iterations and time cost measured by the segmentation results of each algorithm are shown in Table 8.

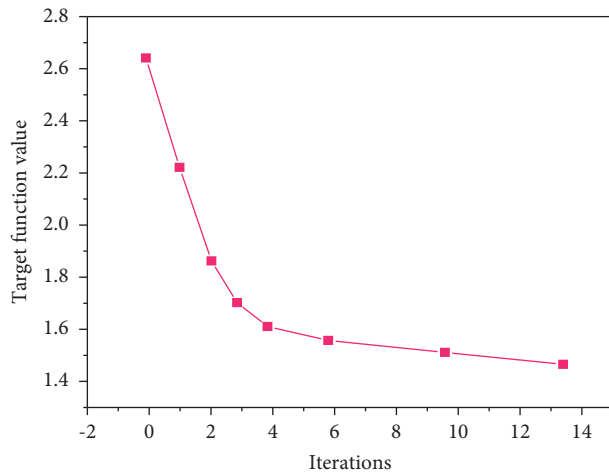
It can be seen from the test results in Table 8 that the number of convergence iterations decreases in the order of FCM, IFCM, FC-PFS, PFCM, PRFCM, and PRFCM_s; At the same time, the number of convergence iterations of PRFCM and PRFCM_s algorithm proposed in this study is more significantly reduced than PFCM algorithm. Although FCM algorithm converges more slowly than PRFCM algorithm, the time cost of FCM algorithm is significantly less than PRFCM algorithm because of its low computational complexity. From the test results, the PRFCM algorithm proposed in this study has certain potential advantages over FCM, IFCM, FC-PFS, and PFCM algorithms. The robust algorithm PRFCM_s of PRFCM has very obvious advantages over other algorithms in terms of convergence iteration times and time overhead.

For three images (all 256×256 in size), salt and pepper noise with probability of 0.3, 0.1 and 0.2 is added to them respectively. FCM, FC-PFS, TPFCA, FCM_s, FLICM, FC-PFS_s and the algorithm ATPFCA proposed in this chapter are used for segmentation test. The test results are shown in Table 9.

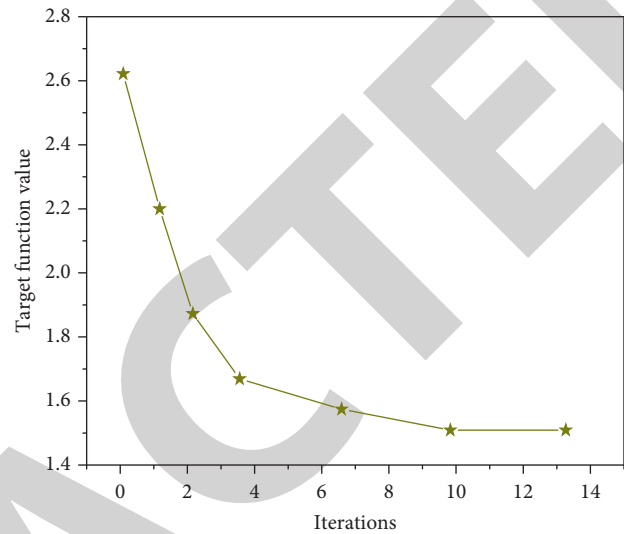
Experimental results show that the total stubbornness-based graphic blur clustering (TPFCA) algorithm can effectively segment different types of images with uneven gray distribution, resulting in a high error rate (maximum signal-to-noise ratio). traditional dimmer C-Medium cluster and graphical dimmer cluster algorithms decreased from approximately 30% to 55% (increased by approximately 19%–33%). The introduction of total divergence improves the effective segmentation of uneven images to a certain extent. Compared with traditional fuzzy c-means clustering, graphic fuzzy clustering, robust fuzzy c-means clustering, fuzzy local information c-means clustering and robust graphic fuzzy clustering, the adaptive robust graphic fuzzy clustering (ATPFCA) algorithm based on total divergence has a stronger ability to segment gray uneven images. The misclassification rate (peak signal-to-noise ratio) of the segmentation result is reduced by about 38%~76% (increased by about 21%~67%) compared with the above clustering algorithm. Compared with the TPFCA algorithm, the effective segmentation degree of uneven images is further improved. For noisy images, the error rate (peak signal-to-noise ratio) of the ATPFCA algorithm corresponding to the segmentation results is reduced by about 5%~77%

TABLE 7: Mixed noise interference block image and segmentation results.

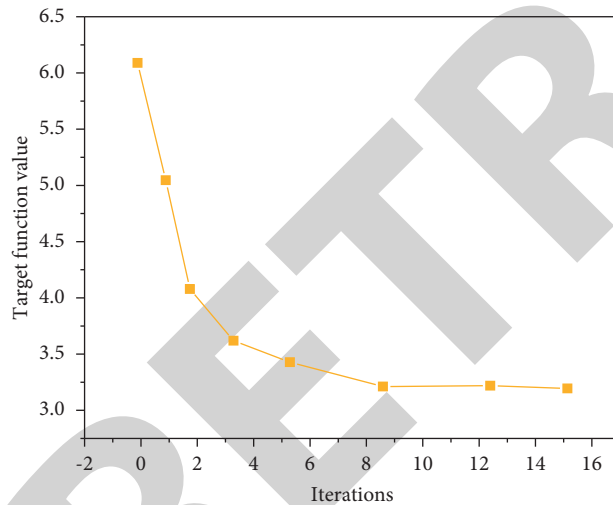
Noisy image	FCM_s	IFCM_s	FC-PFS_s	PFCM_s	PFCM_s algorithm
Han Zishu	14.1110	7.1681	14.1701	13.5605	15.0066
River remote sensing map	23.0870	8.8004	23.1885	20.8580	24.1303
Photographer	18.3008	18.7328	19.4553	18.1001	20.11034



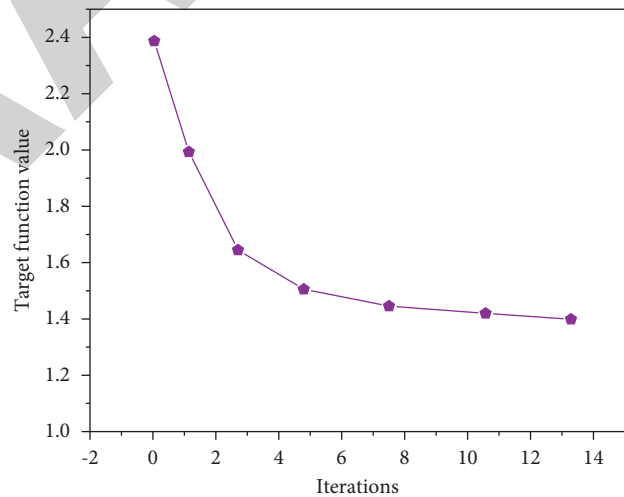
(a)



(b)



(c)



(d)

FIGURE 3: Clustering segmentation test curve of barrel diagram and its noise interference diagram. (a) No noise interference. (b) Gaussian noise interference. (c) Salt and pepper noise interference. (d) Mixed noise interference.

TABLE 8: Convergence iteration times of different algorithms.

Noisy image	FCM algorithm	IFCM algorithm	FC-PFS algorithm	PFCM algorithm	PRFCM algorithm	PFCM_s algorithm
Rice grain	8	19	8	7	4	2
Photographer	10	14	7	5	3	1
River remote sensing	8	13	6	6	4	2
Wheel	12	19	8	10	7	2

(increased by about 6%~230%, especially up to 230% relative to FCM) compared with FCM, FC-PFS, TPFCA, FCM_s, FLICM, literature algorithm and FC-PFS_s. The embedding

of adaptive pixel spatial neighborhood information not only improves the effective segmentation degree of the algorithm for gray uneven images but also enhances the anti-noise

TABLE 9: Error rate and peak signal-to-noise ratio of salt and pepper noise image segmentation results.

Noisy image	Evaluating indicator	FCM	IFCM_s	TPFCA	FCM_s	FLICM	FC-PFS_s	ATPFCA
Synthetic diagram	Misclassification rate (%)	38.06	38.01	38.07	34.27	35.30	34.31	23.26
	Signal-to-noise ratio (dB)	9.1328	9.1461	9.1327	16.3671	14.7200	16.4256	30.2343
Airport remote sensing map	Misclassification rate (%)	10.67	10.23	11.60	6.30	6.76	6.12	4.15
	Signal-to-noise ratio (dB)	9.1776	9.3444	8.8514	10.8285	10.5206	10.8607	12.6045
Industrial remote sensing map	Misclassification rate (%)	30.18	28.41	25.10	20.73	21.37	21.16	10.80
	Signal-to-noise ratio (dB)	10.458	10.5523	10.7501	14.6770	14.3500	14.6004	17.5355

robustness of the algorithm. The embedding of adaptive pixel spatial neighborhood information not only improves the effective segmentation degree of the algorithm for gray uneven images but also enhances the anti-noise robustness of the algorithm.

5. Conclusion

This study modifies and improves the existing graphic fuzzy clustering algorithm. First, aiming at the ill-posed problem of the PFCM algorithm, this study uses neutrality and rejection to construct regular terms and embed the objective function of the algorithm to enhance the correlation between the attribute parameters of fuzzy sets of sample graphics, so as to solve the ill-posed problem of PFCM algorithm. Second, aiming at the noise sensitivity of the PFCM algorithm, which is the same as the traditional fuzzy clustering algorithm, combined with the robust idea of FCM_s1 and FCM_s2 algorithms, the objective function of a reliable segmentation algorithm for a graphical blur cluster (RPFCM_s) was developed. Experiments have shown that the RPFCM_s algorithm achieves better segmentation results and effectively suppresses noise interference in images through several standard images, Gaussian noise, salt and pepper noise, and mixed noise segmentation.

Image segmentation algorithms based on fuzzy set theory belong to the uncontrolled iteration algorithm, and the ambiguous C-means clustering algorithm is widely used in various fields due to its simple structure, ease of implementation, and scalability. In Zade's obscure set theory, there is only one dependent variable of an attribute parameter. The theory of graphic fuzzy set makes the attribution description of pixels in the image more reasonable. However, there are some problems in the current graphic fuzzy clustering algorithm. This study mainly makes systematic research on the problems of the existing graphic fuzzy clustering algorithm. The main research results are as follows:

- (1) Aiming at the ill-posed problem in the existing graph fuzzy clustering algorithm, this study improves the correlation between various attribute parameters by closely associating the neutrality and rejection degree, and solves the phenomenon of misclassification and misclassification in the original graph fuzzy clustering algorithm due to the ill-posed problem. According to the nature of the objective function of the proposed algorithm, the unity of the algorithm was developed and proved with the idea of division

and victory, and the unity of the objective function of the algorithm was confirmed using standard gray images and noise interference images.

- (2) Experimental results under the same hardware conditions show that the improved RPFCM algorithm performs faster merging performance than other algorithms such as FCM, IFCM, FC-PFS, and PFCM. The RPFCM algorithm shows better segmentation performance than existing PFCM algorithms.
- (3) Like other fuzzy clustering algorithms, the PRFCM algorithm still has the defect of being sensitive to noise. Therefore, the pixel gray spatial neighborhood information is integrated into the objective function of the clustering segmentation algorithm to obtain the PRFCM_s algorithm. From the test results, it can be seen that the algorithm has a stronger noise suppression ability. Because the neighborhood information weight factor in the PRFCM_s algorithm is an artificial parameter, which is not conducive to its further promotion, the artificial parameter needs to be optimized in the next step to facilitate the successful promotion and application of the algorithm.

Image-based 3D reconstruction technology is a mathematical process and calculation technology that uses 2D projection to restore 3D information about an object. Among them, the vision-based three-dimensional reconstruction technology uses a camera as a sensor to obtain two-dimensional images, and comprehensively uses image processing, visual computing and other technologies to reconstruct the three-dimensional information of objects with computer programs to complete the scene reproduction of the real environment, so that humans can better perceive external information. At present, due to the continuous improvement of 3D reconstruction algorithms, the increasingly automated modeling process, the lighter labor intensity, and the reduction of equipment costs, 3D reconstruction based on computer vision is suitable for reconstruction of any scene.

Data Availability

The labeled data set used to support the findings of this study is available from the author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

Retraction

Retracted: Analysis of the Structure of Aerobics Complete Sets of Movements Based on Genetic Algorithm

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. Yang, F. Miao, and X. Deng, "Analysis of the Structure of Aerobics Complete Sets of Movements Based on Genetic Algorithm," *Security and Communication Networks*, vol. 2022, Article ID 9063568, 9 pages, 2022.

Research Article

Analysis of the Structure of Aerobics Complete Sets of Movements Based on Genetic Algorithm

Huiyun Yang,¹ Feng Miao ,² and Xue Deng³

¹School of Physical Education and Health, Zhaoqing University, Zhaoqing 526061, China

²Cangzhou Normal University, Cangzhou, Hebei 061000, China

³Hebei Vocational University of Technology and Engineering, Xingtai, Hebei 054035, China

Correspondence should be addressed to Feng Miao; czdance@caztc.edu.cn

Received 21 June 2022; Revised 4 July 2022; Accepted 19 July 2022; Published 12 August 2022

Academic Editor: Tao Cui

Copyright © 2022 Huiyun Yang et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

As an independent sport, aerobics is a popular and highly popular sport that integrates group gymnastics, dance, music, fitness, and entertainment. With the continuous development of global fitness fever and happy sports in recent years, the classification of aerobics has become more and more extensive. The development of fitness aerobics and competitive aerobics conforms to the trend of the times. In the course of aerobics teaching, action structure analysis is essential, and the performance of decomposing action image recognition has a direct impact on the effect of aerobics teaching. Therefore, it is important to study an effective aerobics complete set of action structure analysis method. In order to solve the problem that the traditional method is easily affected by the movement rate, lighting conditions, occlusion, complex background, etc., resulting in poor robustness of the recognition results, this paper takes the complete set of aerobics movements as the initial population and then designs the adaptation of the aerobics movements. The degree function is used to realize the structural analysis of aerobics complete sets of movements through the genetic algorithm. First, the video sequence is divided into several segments by using the time energy pyramid, and the human body target for aerobics exercise is extracted by the background subtraction method, and the decomposition actions of aerobics are obtained. By calculating the fitness of different actions, the fitness of the complete set of actions is obtained and then realize the analysis of aerobics complete sets of movements. The structural analysis of aerobics complete sets of movements can not only improve the choreography efficiency of complete sets of movements, but also promote the improvement of the training level of aerobics athletes, and help coaches make relative adjustments and changes in teaching on the basis of the original training of athletes.

1. Introduction

Aerobics originated in the United States. It was first created by the American Dr. Nice Cooper in the 1960s to create a set of exercise systems with cardiopulmonary function training as the main purpose. Since then, it has been promoted to people in all fields of society [1]. Aerobics is highly sought after by aerobics enthusiasts and gradually matures. This is mainly because aerobics has physical fitness, regardless of the age level, suitable for old and young, rich and novel, with a wide range of mass and rich in a distinct sense of rhythm and rhythm characteristics. With the improvement of the project, according to different purposes and tasks and according to the needs of different

groups, aerobics can be divided into three categories: fitness aerobics, competitive aerobics, and performance aerobics [2].

Among them, competitive aerobics is the most representative kind of aerobics, competitive aerobics is highly performative and has strong viewing and fitness value. According to the theory of item groups, it belongs to the skill-led category of difficult and beautiful performances. It is one of the competitive sports, and its main purpose is to “compete and win”. Competitive aerobics is a sport that can perform continuous, complex, and high-intensity complete sets of movements under the accompaniment of music. It is a combination of continuous movements to show athletes “health, strength and beauty”. Competitive aerobics

originated from Traditional fitness aerobics is developed from a series of strict requirements on body flexibility, muscle strength, and endurance, as well as a perfect combination of complex arm movements and seven basic steps under the feet [3]. They completed beautiful, changeable, and smooth sets of movements on a specified 5-square-meter field within a specified time of 1.5 to 2 minutes. A large number of freehand movements were also added to the set of movements at that time. And dance moves and simple technical movement elements have appeared [4].

The necessary condition for competitive aerobics to obtain excellent sports performance is the innovative arrangement of complete sets of movements, and a set of novel complete sets of movements will directly attract the attention of the audience and the referees. Arrange a complete set of competitive aerobics routines, the content must include calisthenic movements, difficult movements, transition and connection movements, lifting and cooperating movements; the content process of the arrangement should reflect a complete set of dynamic and smooth, especially transition and connection movements. The variety of choices and the complex innovation of the movements; the content of the complete set of movements should be taken into account in the balanced and effective use of various areas of the vertical space and the plane space, that is, the ground, standing, vacated and the entire horizontal area, and the time sequence of the complete set of movements. Reasonable adjustments should also be made according to the orchestration requirements [5]. Action choreography has the highest score in the final value judgment of the entire set [6]. Therefore, it is particularly important to analyze the structure of aerobics complete sets of movements, which can not only improve the choreography efficiency of complete sets of movements, but also promote the training level of aerobics athletes, and help coaches make relative teaching based on the original training of athletes. Adjustments and changes. Based on this, this paper takes the complete set of aerobics as the initial population and then designs the fitness function of the aerobics action.

2. State of the Art

Without rules, no circle can be formed. Rules play a decisive role in the development of grading projects. The promulgation of the new cycle of competitive aerobics rules will inevitably promote the development of this project. Only after in-depth research on the rules of competitive aerobics by members has the project developed rapidly in China. According to the rules formulated by aerobics, the action structure of competitive aerobics decomposition is conducive to our understanding of aerobics.

Competitive aerobics complete sets of movements include calisthenic movements, difficult movements, transition/connection movements, formation/position, lift movements, and dynamic coordination [7]. It mainly includes the technical content of the system as shown in Figure 1.

The choreography of the complete set of competitive aerobics movements is gradually becoming more artistic. The high-level artistic expression of competitive aerobics is the

perfect combination of technical beauty and innovative beauty of the complete sets of movements. This development trend is becoming more and more obvious. Difficulty, novelty, and oddity in the choreography of complete sets of actions are the keys to winning. Therefore, the choreography of complete sets of actions is not only the process of arranging simple single actions, but also the organic combination of actions in modeling and music and changing the combination of previous actions. The model, combined with the laws of human body structure, perfectly appears in another innovative form [8]. To create a basic combination of ingenious, increase the effect of the action, make the action strong and powerful, and make the referee impressed and unforgettable after watching it. This is the creative process of tactical adjustment and placement of the main content of the complete set of actions through artistic means. Transition and connection movements are the necessary movements to connect the basic steps, calisthenic movements, difficult movements, lifts, and shapes of aerobics in a set, as well as to achieve space conversion, and are one of the leading factors to make the set seamless and smooth [9]. Transition and connection actions can increase the sense of space in the complete set and act as a bridge and link in the set in terms of adjusting and adjusting and mobilizing physical strength and assisting difficult movements and one of the main criteria for artistry.

Creation technology is an important constituent element of the technical system of competitive aerobics. To improve the creation technique, we must first broaden our creation ideas ideologically. Xianxiong conducted a detailed analysis of the transition and connection movements of the top eight men's singles athletes in the World Championships, analyzed the proportion of transition and connection movements in the complete set of movements, and found that 80% of the men's singles players' transition and connection movements accounted for nearly one-third of the total proportion of the complete set [10]. Xia conducted a tentative study on the creation and editing of competitive aerobics assisted by computer three-dimensional animation technology. Zhang Hong introduced the art term "mutation composition" into the field of aerobics creation, raised the unconscious mutation creation phenomenon in actual creation to the height of theory, and carried out theoretical positioning [11]. Huijun introduced the idea of connection into the creation of competitive aerobics, providing more information and a broader selection space for the creation and creation of jazz dance, Latin dance, and hip-hop in competitive aerobics. Yu pointed out that the use of the visual expression to design aerobics choreography can cause visual impact and infection and can achieve a good choreography effect. Finally, Chunying proposed to explore and analyze the conditions for aerobics complete sets of movements to be protected by copyright law, and thus arouse the creators of aerobics to establish the awareness of intellectual property protection and guide the project to develop better [12]. Through the research of the above scholars, we can find that if athletes want to achieve excellent results in competitive aerobics, they must innovate in the movement structure and have innovative consciousness in the process of aerobics choreography.

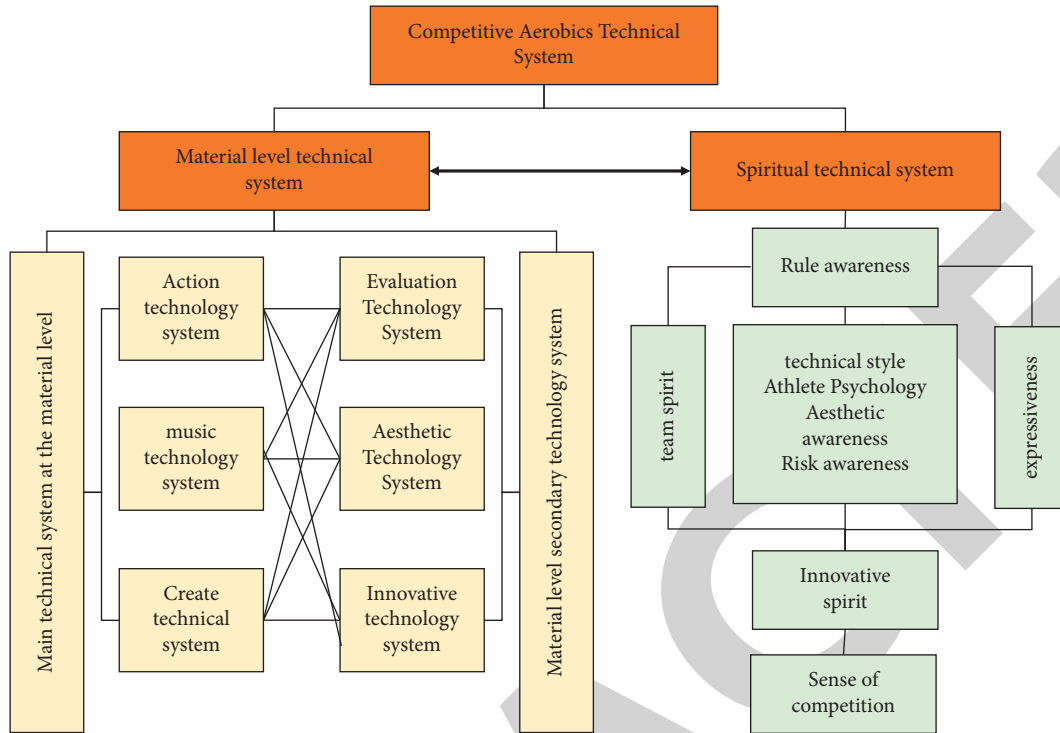


FIGURE 1: Competitive aerobics technical system and its relationship.

In most cases, the number of transition and connection movements used in a set is affected by difficult movements. On the other hand, the new rules advocate the use of multi-dimensional space movements, highlighting the ornamental nature of the set, so that the whole set of movements is not only a single movement surface, a single movement The axes and actions are concentrated in a complete set of spatial levels. The combination of transitions and connecting actions should be used to demonstrate the spatial three-dimensionality of the routine. Generally speaking, a single transition action needs 2–6 shots to complete, and the transition and action take up the shot. In the past routines, most of the knots appeared in a single form [13]. In the development cycle of transition and connection movements, the difficulty of movements gradually increases, the structure becomes more complex and novel, and appears in the routine in the form of combination or superposition, and the action rhythm also increases without reducing the frequency of individual movements. The emergence of this combination of transition and connection movements, on the one hand, increases the viewing value of the movements and the number of movement space transitions, on the other hand, it also requires more time and physical fitness, and requires higher overall quality of the athletes themselves.”

3. Methodology

3.1. *Competitive Aerobics Movement Technical System and Scoring Rules.* Through understanding the technical system of competitive aerobics action, it is conducive to our technical decomposition of competitive aerobics, so as to

promote the training level of aerobics athletes. The movement technique system of competitive aerobics is the core part of the main technical system of the material level of competitive aerobics, and it is also the most important element of the main technical system of the material level of competitive aerobics [14]. According to the division of complete sets of competitive aerobics and the technical characteristics of competitive aerobics in the competition rules of FIG2 009.2012, the technical system of competitive aerobics movements is divided into basic technology, difficulty technology, connection technology (transition connection technology), coordination technology, modeling technology, and control technology are studied in six aspects (see Figure 2).

3.1.1. *Basic Technology.* Basic technique is the most basic and essential element that constitutes the movement technique system of competitive aerobics. Bouncing technology, posture technology, and exercise technology reflect the essential characteristics of competitive aerobics technology, are the basis of competitive aerobics technology, are the symbol of competitive aerobics that distinguishes it from other sports, and are the thing of competitive aerobics. The performance of the fundamental features we call the basic technique [15].

3.1.2. *Difficulty Technology.* Difficulty technique is an important component of the action technique system of competitive aerobics. Without difficulty, there is no competition. There are 359 difficult movements listed in the rules of competitive aerobics. According to whether

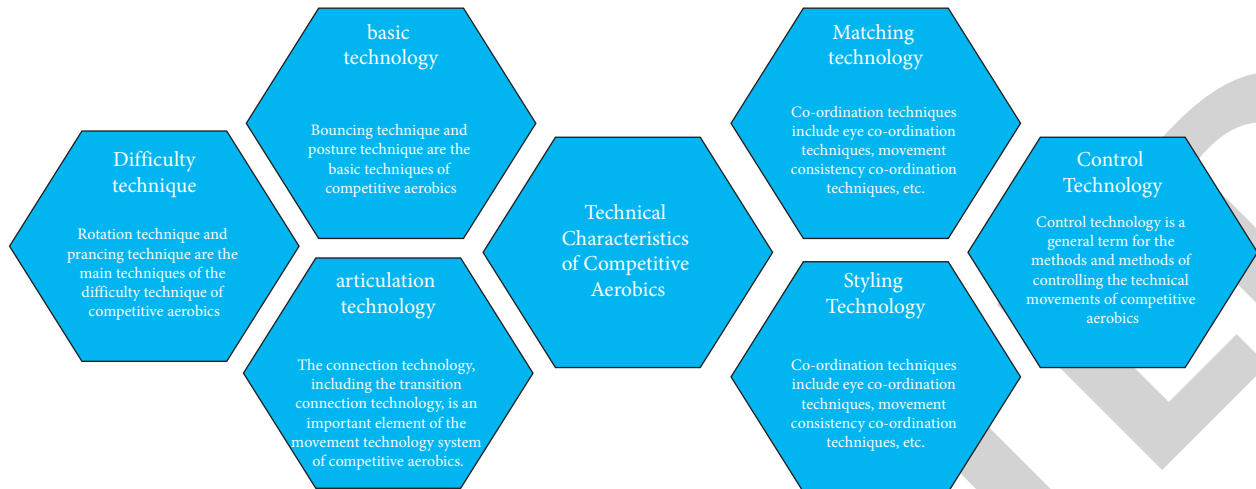


FIGURE 2: Competitive aerobics movement technique system and its relationship.

there is flying in the difficult movements, the difficult movements can be divided into aerial difficult movements and nonaerial difficult movements. The classification is based on the contact between the foot and the ground (impact), i.e., the presence of aeriels (using the ground as a frame of reference), and by analogy, the following classification table is derived, and the difficulty and the amount of impact can be judged as large, medium, or small according to the impact of the movement on the ground. Difficulty movements can be divided into swivel movements and non-swivel movements (see Table 1). It can be seen that the swivel technique and the prancing technique are the main techniques of the difficulty technique of competitive aerobics. The jumping technology includes take-off technology, aerial technology, and landing technology.

3.1.3. Connection Technology. The connection technology includes transition connection technology, which is an important component of the competitive aerobics movement technology system, an important component of the subsystem, and organically connects the competitive aerobics movements and the movements or the elements within the movement technology system to ensure the competitive aerobics.

3.1.4. Matching Technology. Coordination technique is an important “member” in the action technique system of competitive aerobics, and it is the main technical element of the collective project of competitive aerobics. Co-ordination technique refers to the general term for the methods in which individuals and groups cooperate with each other to complete movements, form formation patterns, complete lifts, and create shapes. The coordination techniques include eye coordination technology, movement consistency coordination technology, dynamic coordination technology and lift coordination technology, body position, and formation change coordination technology.

TABLE 1: Classification and quantity of difficult movements.

Action category	Subdivision category	Quantity
Flying class	Swivel class	163
	Non-swivel	49
Nonflying class	Swivel class	81
	Non-swivel	66

3.1.5. Control Technology. The control technology is not only a constituent element in the technical system of competitive aerobics movements, but also the main line running through the technical system of competitive aerobics movements, a complete unity.

Scoring rules are the legal basis for competitive events, and competitive aerobics scoring rules guide the development direction of competitive aerobics. Therefore, to discuss the special characteristics of competitive aerobics, it is necessary to understand the requirements of the scoring rules. “2013–2016 Cycle International Gymnastics Federation Aerobics Scoring Rules” is provided by the International Gymnastics Federation (FIG) Executive Committee and has been officially implemented since January 1, 2013. The requirements of the new rules for competitive aerobics are shown in Table 2.

3.2. Human Gesture Recognition Method. In the structural analysis of aerobics complete sets of movements, the first and foremost is to predict the movement trajectory and movement trend of the athlete’s movements according to the information such as the position and shape of the body parts, and judge whether there are errors or irregular movements in the aerobics movements [16]. Therefore, it requires that the number of keyframe sets should be as few as possible, and the local topological structure of human actions should be expressed more accurately. Embedding the spatiotemporal features of human body parts in the flexible hybrid articulated human body model can effectively improve the robustness of the human body and action recognition, and use human body pose parameters and action features to

TABLE 2: Major adjustments in the new cycle scoring rules.

Content	Require
Fucking	There are clear requirements for the number and route of operation units
Transition link action	Clarified the concept and specific types of violation actions
Skill action	Clarified the concept, type, quantity and connection of skill movements

determine the keyframes of motion video [17]. The so-called “robustness” refers to the control system in a certain (structure, size) parameter perturbation, to maintain some other performance characteristics. That is, the robustness of the system is the key to the system survival in abnormal and dangerous situations. For example, whether the computer software in the input error, disk failure, network overload, or intentional attack, can not crash, is the robustness of the software.

According to the definition of the flexible hybrid articulated human body model, the problem pose p a cost minimization problem, and its cost function $C(I, p)$ is:

$$C(I, p) \propto \sum_{u \in V} \varphi(I, p^u) + \sum_{(u,v) \in E} \psi_{u,v}(p^u - p^v). \quad (1)$$

When the FMP model is calculated by using the optical flow difference between before and after

$$\theta(p_t, p_{t+1}, I_t, I_{t+1}) = \sum_{u \in V} \|p_{t+1}^u - p_t^u - f(p_t^u)\|_2^2. \quad (2)$$

Assuming that the frame image set of a section of motion video is I , and the estimated pose parameter sequence is P , then the cost of obtaining P from I by using the model is:

$$C(I, p) + \sum_{t=1}^{T-1} C(I, p) + \lambda \theta(p_t, p_{t+1}, I_t, I_{t+1}). \quad (3)$$

When using FMP pose viewed. First, without considering the spatiotemporal continuity constraints of human poses, a set of K human poses is generated from a single frame image. Due to motion blur and self-occlusion, some human body parts in Kb , such as the elbows (le, re), wrists (lw, rw), knees (lk, rk) identified by the eight white dots in Figure 3, and ankle joints (la, ra). (called nondeterministic parts), it is difficult to estimate accurately [18]. With the help of the local temporal continuity of human body parts (represented by four dashed edges in Figure 3 to improve the accuracy of human body pose estimation, (3) is modified as:

$$C(I, p) + \sum_{t=1}^{T-1} C(I, p) + \bar{\lambda}_1 \sum_{u \in V} \|p_{t+1}^u - p_t^u - f(p_t^u)\|_2^2. \quad (4)$$

When the K attitude parameters of each frame image are obtained, the optimal is determined by minimizing formula (3), namely:

$$\min_{p_t \in P_{t,vt}} C(I, p) + \sum_{t=1}^{T-1} C(I, p) + \lambda \theta(p_t, p_{t+1}, I_t, I_{t+1}). \quad (5)$$

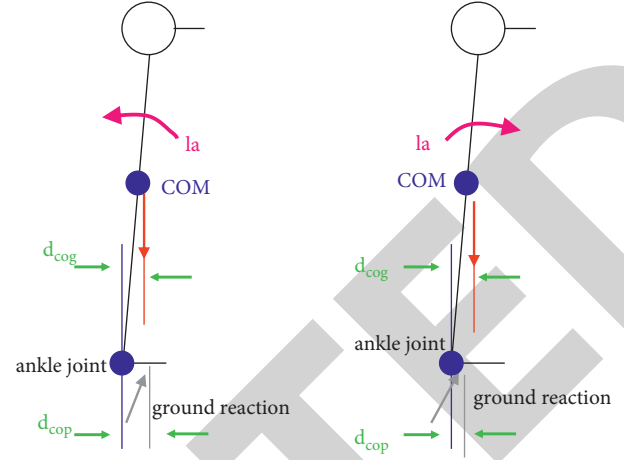


FIGURE 3: Commonly used human body models.

3.3. Analysis of Aerobics Movement Based on Genetic Algorithm

3.3.1. Traditional Genetic Algorithm. Genetic Algorithm, referred to as GA, is a computational model that combines biological evolution and genetics. It can simulate the process of natural biological evolution through mathematical methods, the process of problem-solving, and the selection and crossover of chromosomal genes in the process of biological evolution mutation, etc. [19].

The algorithm steps of the traditional genetic algorithm (GA) are as follows:

Step 1: Initialization: first set a counter $i = 0$ ($i \leq t$), used for statistics of evolutionary algebra, set the most large evolutionary algebra t ($t > 0$), followed by the initialization of the population $P(0)$, the population contains M ($M > 0$).

Step 2: Individual evaluation: calculate the fitness of each individual included in the population $P(i)$, and count the calculation results.

Step 3: Selection operation: perform selection operation on the individuals of the population. Sorting is performed according to the individual fitness of step (2), and then select the optimized individuals that meet the conditions to perform direct genetic operations or generate offspring individuals through pairing and crossover to complete the genetic operations.

Step 4: Crossover operation: perform crossover operation on the individuals of the population. This is the core step of the genetic algorithm. The crossover operator is controlled by the crossover probability to complete the crossover operation on the population, thereby generating a new population.

Step 5: Mutation operation: perform mutation operation on the individuals of the population. Complete the changes to the gene values of individuals in the population after crossover. When a population $P(i)$ has undergone selection, crossover, and mutation operations, a new generation of population $P(i+1)$ will be obtained.

Step 6: Judgment of termination condition: if $i \leq t$, it means that the population has not reached the maximum evolutionary algebra, then $i = i + 1$ to perform step 2; if $i = t$, it means that the population has reached the maximum evolutionary algebra. The optimal solution is output, and the optimal solution is the individual with the maximum fitness, and finally the algorithm is terminated.

The specific flow chart of the traditional is shown in Figure 4.

3.3.2. Improved Genetic Algorithm. The fitness of a single action can be set according to the technical system of competitive aerobics movements and the scoring rules, and punishment items can be set according to the deduction item.

The selection operator used [20] by the traditional genetic algorithm has a large error in the actual selection process [21]. In response to this problem, this study uses the sorting method to improve it and redefines the probability P of the i -th individual being selected after sorting as follows:

$$b = \frac{q_0}{1 - (1 - q_0)\alpha}, \quad (6)$$

$$P = b(1 - q_0)\beta - 1.$$

In the formula, α is the number of the population; q_0 is the probability that the optimal individual is selected; b is the normalized value of q_0 ; β is the position of the i -th individual in the entire population after sorting.

The diversity of calisthenics movements mainly depends on the crossover probability, and the global optimization ability of the genetic algorithm is also directly affected by the crossover probability. Whether the genetic algorithm can avoid the local extreme value is mainly determined by the mutation probability, which are the core factors of the genetic algorithm.

In the calculation of individual similarity, the method of information entropy is used to obtain the specific calculation formula of population information entropy as follows:

$$H(M) = -\frac{1}{N} \sum_{i=1}^N \sum_{j=1}^S P_{ij} \log P_{ij}. \quad (7)$$

Among them, M is the number of individuals, N is the number of individual genes, and S is the number of alleles that can be selected. Therefore, the specific calculation formula of similarity A between individual P and individual Q is as follows:

$$A_{PQ} = \frac{1}{1 + H(2)}. \quad (8)$$

In the traditional genetic algorithm, the value of the crossover probability P_j is a constant, generally set as $0.3 \leq P_j \leq 0.8$. If the selected value of the crossover probability is too large, the global search ability of the genetic algorithm will become stronger, but at the same time, the

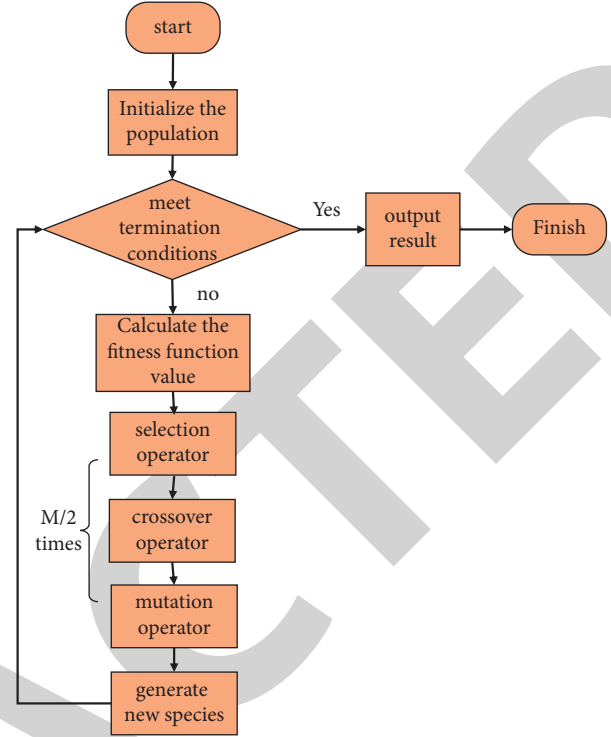


FIGURE 4: Flowchart of genetic algorithm.

original high adaptability of the chromosome will be destroyed. On the contrary, if the selected crossover probability value is too small, the global search ability and convergence speed of the genetic algorithm will decrease. Therefore, in the evolution process of the genetic algorithm, it is necessary to continuously adjust the crossover probability according to the current individual fitness and the number of evolution iterations. The improved crossover probability is

$$P_j = \begin{cases} P_{j\max}, & F_{\max} < F_{\text{mean}}, \\ P_{j\max} - \frac{n}{n_{\max}} (P_{j\max} - P_{j\min}), & F_{\max} \geq F_{\text{mean}}. \end{cases} \quad (9)$$

Similarly, the improved mutation probability can be expressed as:

$$P_b = \begin{cases} P_{b\min}, & F < F_{\text{mean}}, \\ P_{b\min} - \frac{n}{n_{\max}} (P_{b\min} - P_{b\min}), & F \geq F_{\text{mean}}. \end{cases} \quad (10)$$

Among them, F is the fitness value of the parent chromosome in the population.

4. Result Analysis and Discussion

4.1. Effectiveness of Human Action Recognition in Aerobics. Test the body part embedded in the spatiotemporal feature of the non-deterministic part. For comparison experiments, the results are shown in Figure 5.

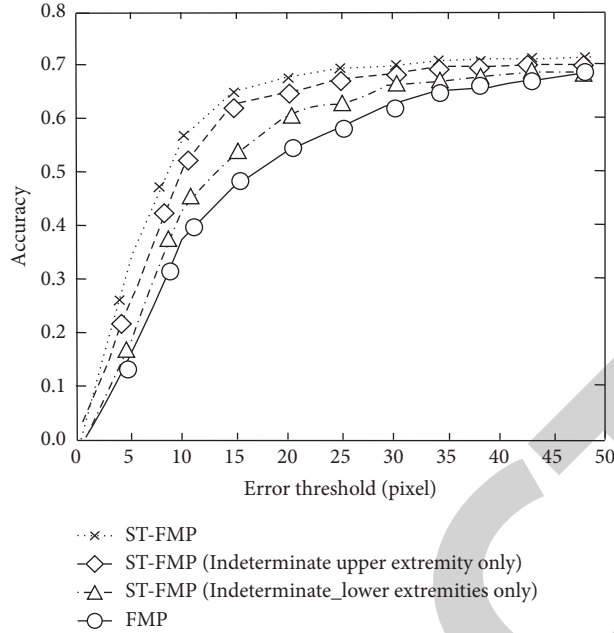


FIGURE 5: Elbow recognition results of aerobics movements.

When using the ST-FMP to estimate the human body pose in the motion video, the accuracy of the non-deterministic parts within a certain pixel error range is significantly improved. Table 3 shows the results.

In order to further verify the recognition accuracy of the method in this paper, the leave-one-out cross-validation method is used for testing during the experiment, that is, some accurate actions of individuals are selected as test data in each round of experiments, and the remaining actions are used as training data. The leave-one cross-validation method is to divide a large data set into k small data sets, with $k-1$ as training set, the remaining one as test set, then select the next as test set, the remaining $k-1$ as training set, and so on. Identify the confusion matrix. The identification results are shown in Table 4. Analysis of Table 4 shows that the method in this paper is used to identify the decomposition movements of aerobics. Only the two decomposition movements of the chest cross and the step have certain recognition errors, resulting in confusion, and the recognition results of the other movements are relatively accurate.

4.2. Analysis of Aerobics Movement Structure Based on Improved Genetic Algorithm. On the basis of the aforementioned experiments, we use a single action of aerobics to form a set of actions and use different sets of actions as groups. The parameter information that needs to be set is shown in Table 5.

In the experiment, aerobics decomposition action database and single aerobics decomposition action database are selected as research databases, which are turn, there are 10 aerobics movements in the videos, which are realized by 12 aerobics athletes in turn. The dataset was shot in the actual environment, contains lighting information, and is partially occluded. Database B contains 15 types of movements of 1 aerobics.

TABLE 3: Performance comparison of different key frame extraction algorithms.

Algorithm	Accuracy	Recall
ST-FMP algorithm	0.99	0.94
KFE algorithm	0.86	0.78
Motion block algorithm	0.76	0.82

The two designed aerobics databases are used as the basis for the structural analysis of the designed set of movements and based on the algorithm designed in the previous section, the body posture recognition of aerobics is realized. According to the movements in database B, a set of aerobics movements is formed, and then database A and the newly formed set of movements are used as the initial population of the function is designed using the evaluation criteria of aerobics, and the complete set of movements is iterated to generate the set of movements with the best evaluation quality. The method of this paper, the dictionary learning method and the hierarchical time memory method are used to analyze the decomposition actions of the choreographed aerobics complete sets of movements, and the analysis and judgment accuracy of the three methods in different scenarios are compared (see Table 6).

It can be seen from the results that among the three methods, the average recognition accuracy of the method studied in this paper is 91.1%, which is higher than the other two methods. Especially in the indoor environment, the accuracy of the method can reach 95.23%. In other scenarios, the accuracy of the method studied in this paper is relatively the highest, which further verifies the accuracy of the method. The structural analysis of aerobics complete set of movements is helpful to the coaches to help athletes optimize the combination of movements, improve the efficiency of aerobics choreography, and is conducive to the improvement of athletes' level.

TABLE 4: Recognition confusion matrix of several typical actions.

	Stretch up	Stretch down	Chest cross	Clasped fist	Step	Swing legs	Step
Stretch up	100	0	0	0	0	0	0
Stretch down	0	100	0	0	0	0	0
Chest cross	0	0	96.3	3.7	0	0	0
Clasped fist	0	0	1.8	98.2	0	0	0
Step	0	0	0	0	100	0	0
Swing legs	0	0	0	0	0	100	0
Step	0	0	0	0	0	0	100

TABLE 5: Experimental parameter information table.

Name	Population	Crossover probability	Mutation probability	Weight ratio	Number of iterations
Symbol	Size	P_c	P_m	T_i	Number
Default setting	50	0.7	0.01	4:3:2:1	500

TABLE 6: Comparison of recognition accuracy of three methods.

Method	Poor lighting conditions (%)	Indoor scene (%)	Outdoor scene (%)	Average value (%)
The method of this paper	91.15	95.23	86.92	91.1
Dictionary learning	85.31	88.25	79.35	84.30
Hierarchical time memory	86.11	91.36	82.19	86.55

5. Conclusion

In recent years, the practice of competitive aerobics in our country has developed rapidly, while the theoretical development is relatively lagging behind, especially the lack of research on the technical system of competitive aerobics affects the further development of the practice of competitive aerobics. It is necessary to systematically study the technical system of competitive aerobics in theory, identify and sort out its internal elements and their interrelationships, improve a comprehensive understanding of the technical system of competitive aerobics, and promote the development of aerobics discipline. The technical system of competitive aerobics is a complex system composed of the technical system at the material level and the technical system at the spiritual level and their interrelationships. The evaluation of aerobics is highly subjective. Based on this background, this paper proposes a complete set of action structure analysis algorithm for aerobics based on genetic algorithm. First, the video sequence is divided into several segments by using the time energy pyramid, and the background subtraction method is used. The human body target for aerobics exercise is extracted, and the decomposition action of aerobics is obtained. By calculating the fitness of different actions, the fitness of the complete set of actions is obtained, and then the analysis of the aerobics complete set of actions is realized. The experimental results show that the method proposed in this paper can realize the structural analysis of aerobics complete sets of movements, not only can improve the choreography efficiency of complete sets of movements, but also promote the improvement of the training level of aerobics athletes, and help coaches in the original training foundation of athletes. It has strong guiding and reference significance to make relative adjustments and changes in teaching.

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

This work was supported by the School of Physical Education and Health, Zhaoqing University.

References

- [1] S. Song and L. Yao, "Retracted article: research on multi-objective optimal image recognition and aerobics teaching system based on footprint image," *Personal and Ubiquitous Computing*, vol. 12, no. 2, pp. 14–21, 2021.
- [2] S. Debnath, R. K. Chandel, and K. Devi, "Mechanism and molecular response of induced genotoxicity and oxidative stress in plants," *The Journal*, vol. 13, no. 6, pp. 97–104, 2021.
- [3] F. F. Campista and J. Silva, "Dynamic analysis of steel-concrete composite building floors subjected to human rhythmic activities," *ce/papers*, vol. 17, no. 6, pp. 55–61, 2019.
- [4] J. Y. Duan, "Analysis of visual error correction method for continuous aerobics action image," *Science Technology and Engineering*, vol. 17, no. 20, pp. 58–66, 2019.
- [5] L. U. Fu-Xiang, "Adaptive recognition method of aerobics decomposition action image based on feature extraction," *Science Technology and Engineering*, vol. 9, no. 3, pp. 44–52, 2019.
- [6] D. O. F. J. Goncalves, C. A. S. E. Silva, and A. J. D. Santos, "Next-generation probiotics as a therapeutic strategy for the

Retraction

Retracted: Construction of Digital Marketing Recommendation Model Based on Random Forest Algorithm

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. Gao and Z. Ding, "Construction of Digital Marketing Recommendation Model Based on Random Forest Algorithm," *Security and Communication Networks*, vol. 2022, Article ID 1871060, 9 pages, 2022.

Research Article

Construction of Digital Marketing Recommendation Model Based on Random Forest Algorithm

Weiji Gao ^{1,2} and Zhihua Ding¹

¹School of Economics and Management, China University of Mining and Technology, Xuzhou 221116, China

²School of Business, Jiangsu Vocational College of Electronic and Information, Huai'an 223001, China

Correspondence should be addressed to Weiji Gao; weijigao1913@sina.com

Received 18 May 2022; Revised 29 June 2022; Accepted 6 July 2022; Published 12 August 2022

Academic Editor: Tao Cui

Copyright © 2022 Weiji Gao and Zhihua Ding. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

The traditional marketing model can no longer meet the needs of users and can not add more benefits to the enterprise, and digital marketing came into being. At present, most of the marketing focus of various enterprises is still mainly on products, and the reflection arc to market changes is long. Therefore, the formulation of marketing activities should always pay attention to changes in user needs and combine corresponding activity planning, product planning, brand building, etc., according to Changes in the target market adjust the content of marketing activities and products in real-time and, at the same time, pay attention to user feedback on products in order to iteratively update products in time, improve product market competitiveness, and optimize the user experience. In this paper, through the study and research of the traditional random forest method and some data processing algorithms, the feature selection and class imbalance problems of random forest are improved, respectively. Through the study of feature selection methods, we can maintain a balance between feature strength and relevance during feature selection and improve the final model classification effect. And through the research and experiment of the imbalanced data classification problem and the random forest algorithm, the method of the random forest model to deal with the imbalanced problem has been improved. After experimental calculation and analysis, it is found that for the effect of the minimum number of samples required for node splitting with different numbers, the best results are obtained when 2 samples are taken as the minimum number of samples required for node splitting, and the average value of the *F1* evaluation is 0.1038; for different specifications, the effect of the random forest is the best using the Gini index, and the average value of its *F1* evaluation is 0.1033; for the effect analysis of random forests with different numbers of trees, 7 to 10 decision trees are the best, and the *F1* evaluation is the best. The average is 0.10175.

1. Introduction

Today is an era of information explosion. Compared with the previous situation of lack of information, massive data resources present a colorful Internet world for users, but a large amount of data presents a severe test to users' screening ability. Faced with the massive amount of information data at this stage, the selection and filtering of information have become a priority target to weigh the pros and cons of a system. A platform with excellent user experience will optimize a large amount of information in various ways and present the information that users need and are most interested in their search results [1]. Recommender systems and search engines can play complementary roles in terms of users'

information retrieval needs. When the user's information needs are clear, the search engine can meet the user's goal, and when the user does not have a clear goal, the recommender system can provide some information for the user to use. A good recommender system can not only provide users with personalized information service needs, but also allow users to have a high degree of trust in it and improve user stickiness. Whenever users cannot clarify their needs, they think of the recommender system [2]. Recommender systems have been widely used in many fields, among which the most typical and promising application field is digital marketing. At the same time, the research enthusiasm for recommender systems has always been high in academia and has gradually formed an independent discipline [3].

The digital marketing recommendation system solves the problem of information overload by recommending new items that the user has little contact with for digital marketing, and these new items are related to the current needs of the user. The digital marketing recommendation system utilizes the data about users, available items, existing transactions, and various types of other data stored in the existing database environment for digital marketing recommendations. Users may or may not accept content recommended by digital marketing, or may provide explicit or implicit feedback over a period of time, which is very valuable to digital marketing recommendation systems [4]. Therefore, all the feedback information of users can be stored in the corresponding database of digital marketing recommendations, so that by using these feedbacks information, the digital marketing recommendation system can generate new digital marketing recommendation when the user has relevant behavior next time. The random forest used at this stage is purely random in feature selection, using a combination of multiple classifiers, each individual classifier votes, and the combined classifier makes predictions based on the returned class label of the vote. The benefit of the combined classifier is that it is more accurate than the individual classifiers in it [5]. Here, decision trees are used as individual classifiers, which are assembled into a forest. Individual decision trees use random selection features to decide the partition at each node. Each tree relies on independent sampling and has the same distribution of random vector values as all trees in the forest.

The problem of classification is a common problem in digital marketing. The so-called classification is to find a set of models that can describe the common characteristics of all the data from the known data, so as to be able to identify the category of the unknown data. When solving a classification problem, a classification algorithm is usually used to build a classification model, which represents a collection of classification knowledge. To solve the classification problem, researchers have proposed hundreds of classification algorithms, which come from different fields and have different functions [6]. Various classification problems in digital marketing can be solved by these classification algorithms. This article will introduce several commonly used classification algorithms in detail and explain the use and feasibility of classification algorithms in digital marketing in combination with marketing cases in actual work. Digital marketing theory is the basic theoretical framework, and the focus of marketing activities is to effectively analyze marketing data and how to use random forests to improve data analysis capabilities. Taking the common classification problem in digital marketing as an example, this paper introduces the principle and definition of the classification problem in detail and the classification problem in digital marketing and uses a random forest algorithm to solve the classification problem.

Chapter arrangement of this paper: Chapter 1 introduces the related scholars' research on random forest algorithm and recommendation system; Chapter 2 introduces random forest algorithm technology; Chapter 3 classifies users based on the actual situation of digital marketing design; Chapter 4

conducts experiments on the optimal value range of each specification of the proposed random forest algorithm for recommendation model and draws the results; and Chapter 5 summarizes the full text.

The innovation of this paper: Through the study and research of the traditional random forest method and some data processing algorithms, the feature selection and class imbalance problems of random forest are improved, respectively. Through the study of feature selection methods, we can maintain a balance between feature strength and relevance during feature selection and improve the final model classification effect. And through the research and experiment of the imbalanced data classification problem and the random forest algorithm, the method of the random forest model to deal with the imbalanced problem has been improved.

2. Related Work

Whether a recommendation system can be accepted by users depends on whether the recommendation algorithm it adopts is accurate and efficient. At present, in the field of mainstream recommendation systems, the random forest algorithm is mainly used. Due to the excellent characteristics of the random forest algorithm, it has been widely used in many fields.

Rumín introduced the Hough transform into the voting mechanism of random forest and obtained the Hough forest algorithm, which is widely used in various target tracking and behavior recognition. Hough forest optimizes and improves the voting process of random forest and uses Hough voting to replace the majority voting mechanism. In addition to the category test, the leaf nodes of the Hough forest also use the generalized Hough transform to estimate the maximum posterior probability in the Hough space to detect the impurity of the offset [7]. Liu et al introduced the concept of the survival tree, improved the random forest construction process, and obtained the random survival forest algorithm. The algorithm also uses the bootstrap resampling method to select N training sets during sampling. The difference is that a generative analysis tree is built for each training set. When voting, the survival function of each tree is calculated. The combined value is the mean survival function, which combines the content of the resulting parse tree and the predictions. When calculating the survival function, the algorithm adopts the method of KM estimation [8]. Hasanat et al. also theoretically proved the consistency of random survival forest and believed that random survival forest (RSF) is significantly better than other survival analysis methods when dealing with high-dimensional data [9]. Ohtake, Seki, and Kodaka proposed to introduce NCL technology into the random forest algorithm, mainly for the unbalanced training set, perform NCL technology processing on the data, and then classify the processed data with the random forest algorithm. The test results show that the improved random forest algorithm. The forest algorithm classification effect is better [10]. Prabhu developed a new cost-sensitive random forest algorithm from the perspective of applying cost-sensitive learning algorithm to solve the

problem of unbalanced dataset classification. The cost-sensitive random forest algorithm first forms multiple bags by performing an alternative random sampling method on the original training set; then randomly selects some attributes in each bag to prune, thereby generating a cost-sensitive decision tree. The bags are combined to form an ensemble algorithm [11]. Mathai and Jeswani proposed a new random forest feature selection algorithm by analyzing the relationship between the strength and correlation coefficient of each tree in random forest. The main idea of the algorithm is to find out through the analysis of the upper bound of the generalization error of random forest: when building a random forest, increasing the strength of the decision tree in the forest can achieve the goal of reducing the generalization error of random forest. But they also found that while increasing the strength, the correlation between decision trees should be minimized [12]. Xiang et al. proposed a method of generating multiple attributes at each node of the decision tree in view of the fact that each node of the traditional decision tree algorithm has only one attribute, and the process of generation and decision-making is complicated. Random forest algorithm uses fewer and targeted attributes to randomly select each data clustering heap to generate multiple multivariate decision trees. Finally, a random forest is formed according to the multiple multivariate decision trees constructed by each clustering heap to carry out the weighted integration of the classifiers, thus trying to cover all the concepts in the dataset and further ensuring the classification accuracy of the random forest algorithm [13]. Feng et al. focused on the relationship between the strength and correlation of each sub-classifier in the RF algorithm, but cannot effectively predict the strength and correlation of the forest before constructing a subtree [14]. Rewade adopts the backward selection method of sequence and generalized sequence for feature selection and proposes an encapsulated feature selection algorithm based on random forest, but this algorithm cannot determine the generalized backward search method in high-dimensional data sets L value [15]. In order to reduce the generalization error of the balanced sample set, the error is reduced by about 15% by changing the sample size of the training set and the sample sampling method, but this method fails to obtain the quantitative relationship between the degree of balance and the sampling interval [16].

From the above aspects of optimization, the improvement of the classification performance of the random forest algorithm mainly focuses on the combination research of various algorithms. The research of these combinations is generally applied in a specific field; the second aspect focuses on the special data set in application optimization in random forest; and the optimization method of the third aspect is mainly through the improvement of the algorithm itself, so that it has certain versatility and can be applied in different fields. This paper intends to start from the second and third aspects to optimize the random forest algorithm to build a digital marketing recommendation model.

3. Introduction to Random Forest Algorithm

3.1. Decision Tree. Before understanding random forest, we must first understand decision tree. Decision tree is a tree structure classification from top to bottom. Its core idea is to find purity classification. Purity means that the target variables can be completely separated, that is, y can only be equal to 0 during classification. or 1. Decision tree is one of the most classic data mining algorithms. It shows the decision-making and classification process in a tree structure, which is simple, intuitive, and highly interpretable. In this article, classification trees are used. In the decision-making process, when the root node is split into leaf nodes according to the characteristic attributes, how to judge the quality of the leaf nodes obtained by splitting? Usually, the Gini index (Gini impurity) is used to judge. Gini index (Gini impurity): indicates that in the sample The probability that a randomly selected sample in the set is wrongly classified, so the smaller the Gini index, the smaller the probability that the selected sample in the set is wrongly classified, that is to say, the higher the purity of the set, the more impure the set is, the more That is, the more impure the split leaf node is [17, 18]. Its mathematical formula is shown as follows:

$$\text{Gini}(p) = \sum_{p=1}^K p_k (p_k - 1) + p_k^2. \quad (1)$$

Among them, p represents the probability that the randomly selected sample belongs to the k category. After the root node is split into two leaf nodes, the purity of the Gini index is calculated. If the purity is small enough and the Gini value is small enough, the two leaf nodes can be regarded as leaves. The nodes are no longer classified. If the purity is high, the above two leaf nodes will be used as a new set and continue to be split until the purity is small enough to meet the standard [19].

Random forest is to create a forest by random method. The forest consists of many decision trees and each decision tree is not correlated. The result is shown in Figure 1.

After the random forest is established, when a new sample enters the forest, each decision tree in the forest performs decision classification to see which class is selected the most to predict which class the new sample belongs to. Since the random forest will randomly sample the input data set with the replacement of rows and columns, the phenomenon of repeated sampling may occur [20]. Assuming that there are m decision trees, m sample sets are required to train each tree. It is not advisable to use full samples to train m trees, because the full samples will ignore the local sample rules, resulting in a weaker generalization ability of the model. With replacement, n samples are extracted, and m decision trees are trained with these n samples, and finally, the prediction classification is obtained. Multiple random variables are usually calculated using the chain rule, as shown in equation (2).

$$p(x_1, x_2 \dots x_n) = p(x_1) \cup px(x_i | x_1 \dots x_{i-1}). \quad (2)$$

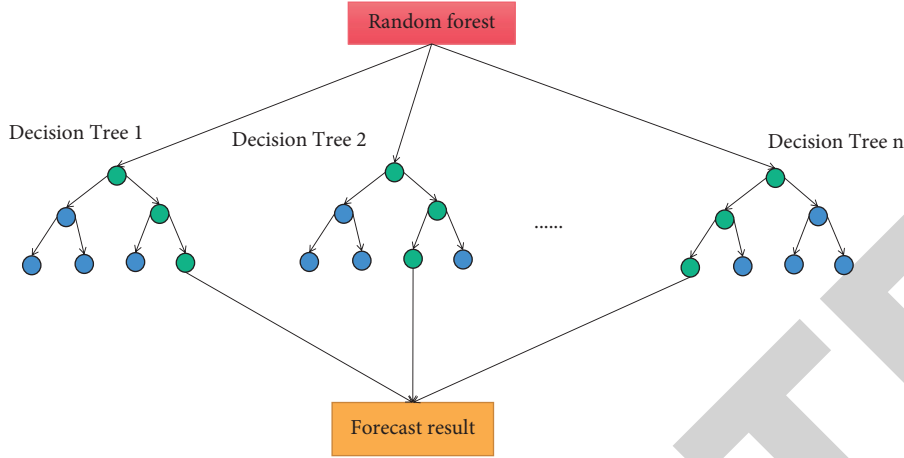


FIGURE 1: Schematic diagram of the principle structure of decision tree.

Random forest has high operating efficiency, simple implementation, and easy to understand, and users do not need too much mathematical or statistical knowledge to operate. In addition to the advantages mentioned above, random forest has a strong anti-overfitting ability and can be applied at the same time to the advantages of classification and regression problems. However, the application effect of random forest in the regression problem is not as good as the classification problem. Because it cannot give a continuous output, it cannot give predictions beyond the data range of the training sample set when solving the regression problem. Data are prone to overfitting. For low-dimensional data sets, the effect will be reduced when predicting, because the advantage of random forest is to deal with high-dimensional and imbalanced data sets.

3.2. Random Forest Generalization Error Estimation. Generalization ability refers to the ability of the trained model to predict unknown data, that is, the ability of the model to correctly reflect fresh samples. The purpose of the machine learning training model is to obtain the laws behind the data that are not easy to find. For new data other than the learning samples with the same laws (same distribution), the model can also give better classification results [21]. If the generalization error is large, the learning performance of the model will be worse, and vice versa, the performance will be better. The generalization error is defined in the following equation:

$$\text{Rexp}(f) = \text{Ep}[L(Y, f(X))p(x, y)dxdy]. \quad (3)$$

From the formula, it can be concluded that the generalization error is the loss function expectation of the model. In theory, the generalization error of random forest can be calculated by the above formula, but in practical scenarios, some indicators cannot be calculated directly by calculating the generalization error. Assess the generalization ability of the model, such as the distribution of samples and the expected output are generally unknown.

From the inside, it can be considered from the number of features, the maximum depth of each decision tree, the

minimum number of samples required for internal node subdivision, the classification strength of the tree, the correlation between trees, and the minimum impurity of node division. From the perspective of external factors, it is mainly affected by the imbalance of the data of the sample itself, the size of the training sample, the number of features, and the type of features. Generally speaking, the higher the separation accuracy, the better the classification of the algorithm, and its verification index formula is shown in the following equation:

$$J(y_i, y_i) = \frac{|y_i \cap y_i|}{|y_i \cup y_i|}. \quad (4)$$

The overall performance of the algorithm on the test set is obtained through the sample prediction situation. If the actual situation is completely consistent with the predicted result, the coefficient is 1. On the contrary, if it does not match, the coefficient is 0. The data binary classification matrix is shown in Table 1.

Suppose there are two categories in the data set, in which the row represents the required predicted value for prediction, and the column represents the true classification label value, which is called positive and negative classes, respectively. The classification evaluation index is shown in the following formula:

$$\text{ACC} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}}. \quad (5)$$

This indicator is used to evaluate the correct ratio of random forests to the overall classification of the test set. The closer the prediction results are to the real situation, the closer to 1. Generally speaking, the higher the separation accuracy, the better the classification of the algorithm.

4. Construction of User Classification Model Based on Digital Marketing

4.1. Classification of User Behavior. User behaviors are generally divided into two types in personalized recommendation systems, namely, explicit feedback behaviors and

TABLE 1: Confusion matrix for binary data.

Classification of data sets	Classified positive	Classified negative
Positive	TP	FN
Negative	FP	TN

implicit feedback behaviors. Explicit feedback behaviors are those behaviors that clearly show how much the user likes or dislikes the item. The most commonly used explicit feedback method is the user's rating or intuitive feedback on a product. The user's rating results are often at the extremes of the highest score and the lowest score, and other options are rarely clicked by users.

Corresponding to explicit feedback is implicit feedback. Implicit feedback also reflects the user's behavior habits, but it refers to those behaviors that cannot clearly reflect the user's preferences. The most representative invisible feedback behavior is the website visit data. When a user is visiting, browsing a page of an item does not mean that the user must like the item displayed on this page. Compared with explicit feedback, although implicit feedback cannot clearly show the user's preferences and interests, the amount of implicit feedback data is very large, and at the same time, it has a great impact on the smoothness of analysis and modeling. And in many platforms, many users even only have implicit feedback data, but no explicit feedback data. For example, it may be because the product link is displayed on the home page, and the user is more likely to click it.himself. The difference between explicit feedback and invisible feedback behavior is that explicit behavior can more intuitively express the user's liking or dislike for a product, thereby generating interactive behavior, while invisible behavior relies on a larger amount of data to count users' in-depth behaviors, habits, and the differences between them are shown in Table 2.

User interests are constantly changing over time, and the changes in user interests mentioned here are active factors generated by the user's own reasons. The most common example is that as users grow older, they like to watch cartoons when they are young and like to watch action movies when they grow up. Another R & D staff gradually transitioned from reading entry books to reading professional books with the increase in working years. Another person has graduated and started working, and his interests after work have changed compared with those of his student days.

The other is the item life cycle. Like movie predictions, a movie's popularity is affected by its life cycle and will soon: out of people's sight. Affected by this, when the recommendation system decides to recommend an item to a user at a certain moment, it needs to consider whether the item is out of date at that moment. For example, the recommendation result for a football fan in the news recommendation includes the news of a certain team ten years ago, which obviously lacks consideration of the time factor. Items in different industries have different life cycles. For example, the life cycle of news is very short, while the life cycle of movies is relatively long and other factors must be considered comprehensively.

4.2. Analysis of Cold Start and Long Tail Effect. The recommender system builds a model based on the user's historical behavior data and then obtains the possible behavior or interest points of the user in the future through the model. Therefore, the historical behavior data become an important part and prerequisite of the recommender system. However, many websites or scholars from research institutions research the performance of recommender systems. For those platforms that hope to have personalized recommendation applications in the operation stage, how to design a personalized recommendation system without a large amount of behavioral data are the content that needs to be researched in the problem of cold and late action. In general cold start, problems fall into the following categories. The first is the user-level cold start. The user's cold start problem is mainly aimed at new users. This problem exists on both new and old platforms. When a user enters the system, the user's behavior data do not exist in the data set, and there is no way to model the user. The second is the cold start of items. The cold start of items is the same as the cold start of users, and it is also for recent items. The last is the cold start of the system. The cold start of the system mainly occurs when the new platform starts to provide personalized recommendation services.

When conducting multi-attribute decision-making analysis, first, the specific problem to be solved should be put forward by the decision-maker, and it should be analyzed whether the problem belongs to this range; second, the possible solutions to the problem should be listed; then, the attribute values of each solution should be listed information and the relationship information between attributes and attributes; then all schemes are sorted and the best scheme is selected; finally, the decision maker selects one or more schemes according to objective conditions, as shown in Figure 2.

Generally speaking, non-personalized recommendations can be provided for cold start. The simplest example of non-personalized recommendations is the popular rankings. The recommendation system can recommend popular rankings to users, and then wait until a certain amount of user data is collected before switching for personalized recommendations. For the cold start of users, the age, gender, and other data provided by the user during registration can be used to personalize the user portrait. In addition, with the authorization of the social network, the user's friend information and related knowledge on the social networking site can be introduced, and then the recommendation can be made according to his friend's hobbies. The other is the user's point of interest feedback, which allows users to select their own points of interest when entering the system, and then make recommendations based on the points of interest. For newly added items, we can make relevant recommendations based on the attribute information of the items. In the face of the system cold start problem, the best method is expert recommendation, and expert knowledge can be used to display the results. The above schemes also have good applications in the later data to meet the personalized recommendation.

TABLE 2: The difference between explicit feedback and implicit feedback.

	Explicit feedback data	Implicit feedback data
User interest response	Clear	Unclear
Amount of data	Smaller	Huge
Real-time	Real time	With delay
Positive and negative feedback	Both include	Only positive feedback

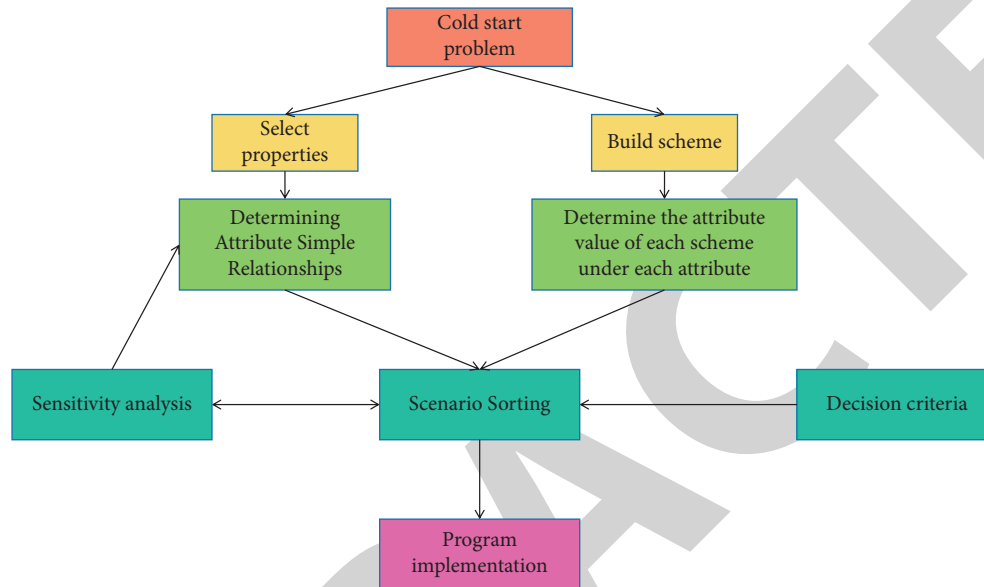


FIGURE 2: Cold start decision analysis.

4.3. Iterative Fusion of Classified Data and Data Feature Selection. In feature selection, select intuitive features such as the number of clicks, the number of favorites, the number of shopping carts, and the number of purchases. Calculation of interactive behavior between users and brands, such as click-to-purchase ratio, purchase days, and distance variance of purchase days. Based on in-depth mining of user behavior, combined with collaborative filtering and feature selection of solid theory algorithm results, such as brand popularity, user behavior similarity, and other related features. Finally, the selection of features is based on forgetting time. Through data aggregation, this paper found that some users have millions of clicks but they have any purchase behavior. Therefore, this paper thinks that these users should be dealt with separately. Later, after analysis, it is found that these users may use crawler programs to automatically visit the target website. Recommendation results have a big impact. In this paper, noise removal is carried out. In this paper, the user's behavior is regarded as noise data, and the user's behavior data are removed from the data set.

This paper uses OPSD cluster and conducts three experiments. Compared with a single algorithm, the boosting-based algorithm has obtained good results in the experiment, while the random forest has poor robustness at some times, as shown in Figure 3.

In this paper, the fusion algorithm model based on random forest and boosting ideas has been tested many

times on the big data platform, and the algorithm has also achieved stable results. The experimental results are shown in Figure 4.

Figure 4 shows the distribution diagram of the results of the 9 tests. It is found that the $F1$ score results are all stable at about 5%. A very important algorithm validity test under big data is the random sampling result. During the tuning process, in the sixth result, because the median TOPN used is smaller, the recall rate is reduced and the accuracy rate is higher, but the overall result remains at 5%.

Overfitting is the process of model parameter fitting. Since the training data contain sampling error, the complex model during training also takes the sampling error into account, and the sampling error is also well fitted, resulting in the model performing well on the training set. But the effect is poor when applied in practice. The generalization ability of the model is weak. Generalization ability refers to the predictive ability of the model learned by the algorithm to unknown data. The number of sample sets is too small, and the main reason for overfitting occurs when there is a large amount of noisy data in the sample training set. There are usually three solutions to overfitting. Because the sample data dimension is too small, it is easy to cause overfitting. Therefore, according to the independent and identical distribution assumption, more data tend to be more accurate in estimating the overall distribution of the sample space. However, in practical applications, due to various reasons, it is not always possible to obtain enough data. The popular

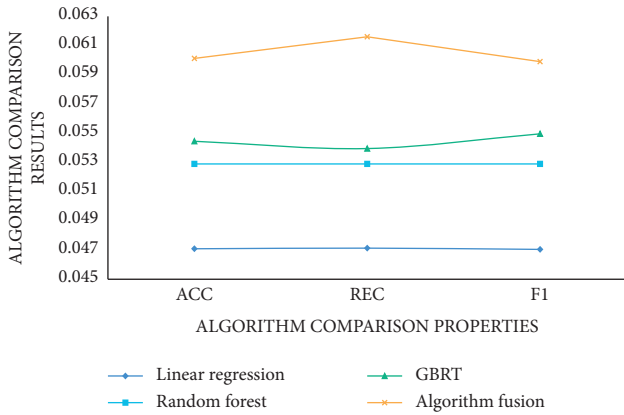


FIGURE 3: Comparison of algorithm effects.

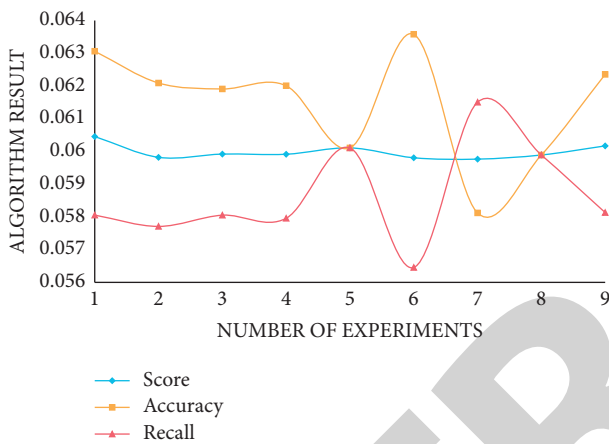


FIGURE 4: Results of multiple algorithms.

understanding of data expansion is to add data with the same characteristics or similar characteristics according to the characteristics of the existing sample training set on the basis of the existing sample training set. You can collect more data from the data source or copy the original sample data set and randomly add a small amount of noise data, etc.

5. Recommended Model Experimental Analysis

5.1. *Classification Indicators Based on Digital Marketing Commodities.* For random forest models, the decision trees in each ensemble model are sampled from the training set using Bootstrap’s method. When a node is split, it does not need to consider all the features, but extracts a part of all the features as a subset, and finds the best splitting feature and the best splitting point from the feature subset. Due to the randomness of random forests, the bias of random forests tends to increase slightly than that of a single decision tree, and due to the combined averaging of multiple trees, the variance of random forests tends to decrease and is sufficient to compensate for the decrease in bias, so we can get a better model.

The classic random forest method uses the combined voting method of decision trees to predict the results. Here, multiple decision trees are used to predict the average of the

probability of the results. As the final result, the default probability of 50% will be used as the two categories demarcation line. Usually, the implementation of random forest is based on decision tree, using chaotic combination technology. When the model is built, a series of classifiers are composed of randomly extracted data and features, and the results of multiple classifiers are averaged as the final result output. The input to the random forest classifier consists of two arrays, which together form the training set. In addition, for a random forest classifier, it also saves some parameters required for the establishment of the entire model, including the number of trees used, the feature dimension randomly extracted from each node, and the child nodes after the decision tree are split.

In the first stage, predict which sessions have bribe behaviors, use the extracted session-related features, use the default parameters of the random forest model, and set the number of trees to 5. Since in the problem of the recommender system, the purchase proportion of behaviors is generally very small, so it is an imbalance problem. Here, other indicators need to be used to judge the quality of the model. Parameter optimization is carried out for the model that predicts whether there is a purchase behavior in a session, and the features used include session features and date features, and the number of features is 10. First, adjust the number of the most important parameter trees, as shown in Figure 5.

It can be found from Figure 5 that for this problem, the best effect is obtained when the number of trees is controlled at about 7–10 of the number of features. There are many different implementation algorithms for decision trees in random forests, and CART uses the Gini index to complete the generation of decision trees. In random forests, you can also compare and choose a better decision tree to use to complete model training. The results are shown in Figure 6.

It can be seen from Figure 6 that the effect of using the Gini index is the best. Through the research and improvement of the random forest class imbalance problem, the accuracy of the model can be improved to a certain extent. By combining the balanced random forest and the weighted random forest, the loss and redundancy of data information caused by resampling can be solved, the data of all rare classes can be selected, and the accuracy of the model can be guaranteed by weighting. Furthermore, the difference between decision trees is guaranteed.

5.2. *Recommendation Improvement Experiment Based on Feature Index.* Random forests also come in different forms, including normal random forests and random forests that include additional trees. In the latter, the tree does one more random step when it splits. When selecting split points, a series of random feature subsets are used. However, instead of finding the most discriminative threshold, a threshold is randomly selected for each candidate feature, and then selected from these randomly generated thresholds. The optimal threshold is used as the split judgment condition.

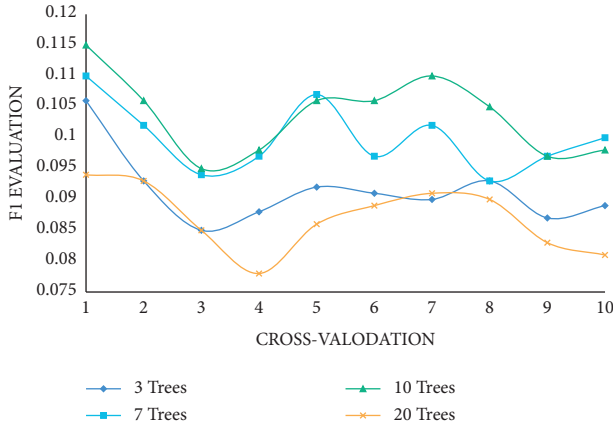


FIGURE 5: Effect analysis of random forests with different numbers of trees.

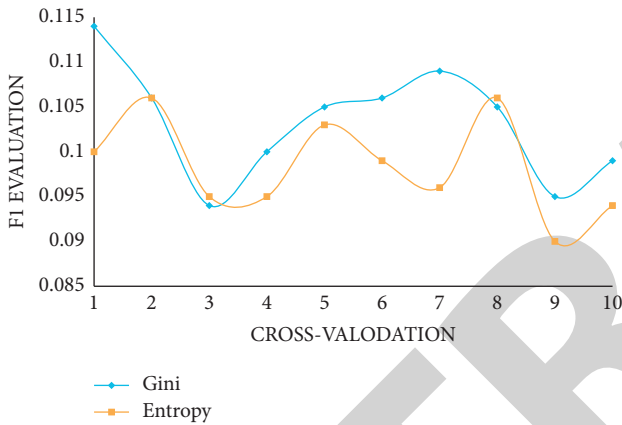


FIGURE 6: The effect of random forests with different norms.

Doing so usually reduces the variance of the model while slightly increasing the bias of the model.

In a decision tree, when finding the best split point, it is necessary to use the relevant indicators of the calculated features to select appropriate features, and the quantification of the selected features will affect the final result. Commonly used selection methods include the square root of the total number of features, the logarithm value, and the number of samples required for splitting all feature extraction nodes, which determine the degree of splitting of a tree and also affect the height of the tree. The selection of different nodes is experimentally analyzed. The experiments are shown in Figure 7.

It can be seen from the results in Figure 7 that the minimum number of samples that needs to be included when a new leaf node is created affects the purity of each node of the tree. If the node obtained after splitting contains samples smaller than this value, it will be discarded. If the value is too large, it will result in a lack of discrimination between nodes. The best results are obtained when 2 samples are taken as the minimum number of samples required for node splitting, which ensures that the decision tree is completely split.

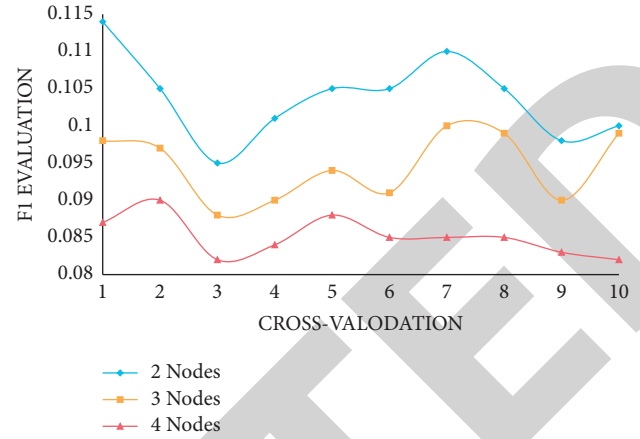


FIGURE 7: The effect of the minimum number of samples required for different number of node splits.

6. Conclusions

With the development of modern e-commerce websites, recommender systems have become the core business of many companies in the modern Internet industry, and combinatorial models in machine random forest algorithms are often used in recommender systems. As an ensemble learning method, the random forest algorithm votes through the combined prediction results of multiple decision trees to improve the prediction effect. The random forest algorithm has many advantages over other linear classifiers, not only the accuracy of the result prediction is improved, but the generalization error is also smaller, and the processing of high-dimensional data is also efficient, the training process is fast, and can be parallelized accomplish. Therefore, it is necessary to study the optimization and application of random forests in recommender systems, in which feature selection and imbalanced classification are both problems that data mining often encounters in real big data. Through experimental analysis, this paper finds the effect of the digital marketing recommendation model on the minimum number of samples required for node splitting with different numbers of nodes. The best results are obtained when 2 samples are taken as the minimum number of samples required for node splitting, and the average value of the *F1* evaluation is 0.1038. For the effect of using Gini index is the best, and the average value of its *F1* evaluation is 0.1033; for the effect analysis of random forests with different numbers of trees, 7 to 10 decision trees are the best, and its average value is 0.1033. The mean value of the *F1* assessment was 0.10175.

At present, for the application of random forest in the recommendation system, more in-depth and broader research can be carried out. In terms of feature selection, this paper only studies the feature selection scheme of random selection and linear combination. The removal of information redundancy and information overlap between trees is also a direction that can be researched; for the balanced classification problem, this paper combines the algorithms of

Retraction

Retracted: Green City Landscape Design Based on GIS System

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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] Y. Liang and H. Wang, "Green City Landscape Design Based on GIS System," *Security and Communication Networks*, vol. 2022, Article ID 5155677, 10 pages, 2022.

Research Article

Green City Landscape Design Based on GIS System

Yanlan Liang¹ and Huijing Wang² 

¹Anyang Institute of Technology, Anyang 455000, China

²Xingtai University, Xingtai 054001, China

Correspondence should be addressed to Huijing Wang; 199710598@xttc.edu.cn

Received 21 June 2022; Revised 9 July 2022; Accepted 21 July 2022; Published 9 August 2022

Academic Editor: Tao Cui

Copyright © 2022 Yanlan Liang and Huijing Wang. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

In order to solve the problem of green urban garden landscape design, a green urban garden landscape design method based on GIS system is proposed. This method introduces component GIS and compares three AO-based GIS secondary development modes. Based on the developed solution, comprehensively considering the index evaluation of urban landscaping and its influencing factors, the functional structure of the GIS-based landscaping management information system is designed, and the system requirements are analyzed in detail. It solves the problem that the cost of traditional green urban garden landscape design is too high, and the experiment proves that improving the landscape environment of urban public space has practical value for the research of urban landscape system. Combined with practical application, it is found that the intervention of rainwater landscape can effectively improve the aesthetics and artistry of urban rainwater public facilities. At the same time, the development of GIS and its related technologies (such as database technology and network technology) has also promoted the construction and development of urban landscaping system, which has a great effect on the beautification of the environment, which verifies the validity of the experiment.

1. Introduction

An important index to measure the level of urban greening is the urban green space rate (public green space, residential green space, unit affiliated green space, protective green space, production green space, and scenic forest land) and the green time coefficient. An important indicator for evaluating the level of urban greening is the urban green space rate. In the comprehensive aerial remote sensing survey, through the combination of remote sensing image interpretation and field measurement, the relationship between remote sensing image characteristics and plant height and DBH is found out, and the “three-dimensional greening index” or “green quantity” index is proposed to replace the original “greening coverage” index to evaluate the urban greening level [1]. The study points out that the grassland, shrub, and tree in the same area have the same green coverage, but have different green amount. Under the condition of the same area, the order of its ecological functions (oxygen production and CO₂ absorption) is:

tree > shrub > ground cover or lawn, and the ecological function of trees is ten times that of lawn or ground cover. Tall trees are the main elements for the selection of scenery in the residential area. To improve the level of urban greening, we should not only improve the greening coverage, but also improve the “three-dimensional greening index,” that is, to improve the quality of greening. Geographic information system (GIS) has been widely used in agriculture, forestry, and other industries in various countries. In China’s urban landscaping management, some cities have developed urban landscaping management information systems in line with their actual conditions. Using geographic information system (GIS), we can timely and accurately understand the current situation and changes of urban green space resources and establish a landscaping system with the help of GIS and its spatial analysis function, which can improve the efficiency of urban landscaping management. Therefore, combined with the actual situation, the development of a set of local urban landscaping management information system with the help of ArcGIS Engine

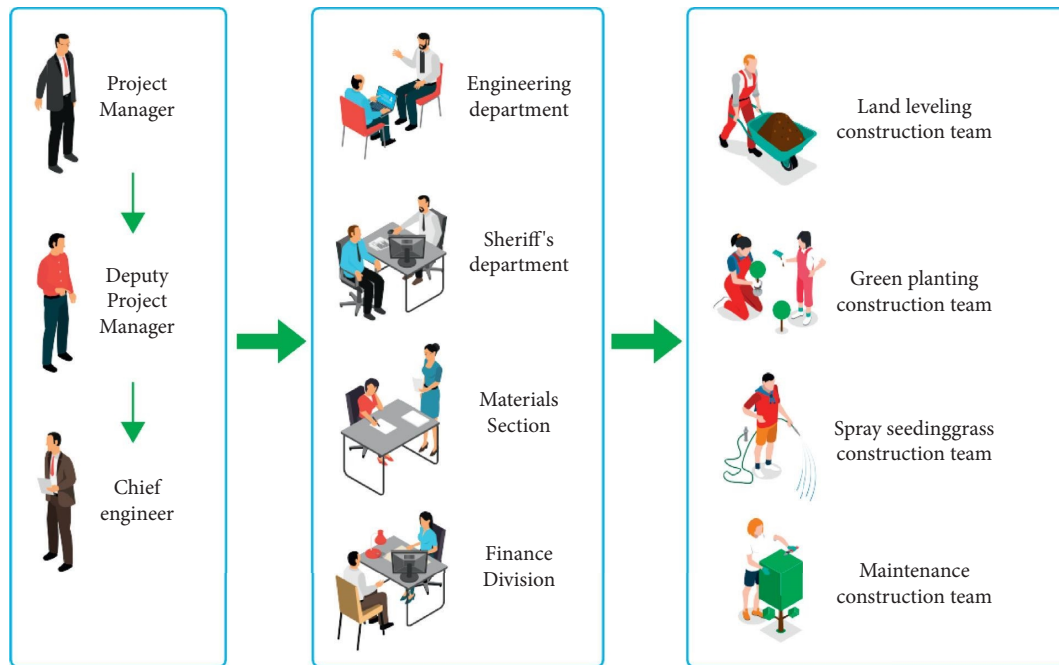


FIGURE 1: Block diagram of construction organization.

can not only improve the greening management efficiency and realize scientific management, but also provide data statistics and other functions for the landscaping department, so as to improve the work efficiency and data accuracy, which is of great significance to improve the management of urban ecological construction [2]. As shown in Figure 1, ArcObject component set is a series of COM component set developed by C++ and based on Microsoft COM technology. It is the development platform for the applications like ArcMap, ArcCatalog, and ArcScene in the ArcGIS family.

2. Literature Review

Gu and Wei, in the middle of the last century, began the theoretical research on the application of information management to specific work [3]. Americans first invented computer-integrated manufacturing system in the early stage, and then, further evolved into management information system, which is widely used in all walks of life. Wang believes that in the following decades, information technology has developed greatly, and in the 1990s, it has made a qualitative leap [4]. Shan et al. found that the definition of the so-called enterprise information management is to adopt digital processing for all steps in the operation of the enterprise and use the current computer information technology for integrated processing, which is conducive to improving the work efficiency of the enterprise, the development of the global economy, and the core competitiveness of the enterprise [5]. Hu and Gong found that since the twenty-first century, most of the European and American countries led by the United States and Britain have realized enterprise information management, which can increase the competitive strength of enterprises [6]. Deng et al. believe that China has experienced more than 30 years of reform,

opening up and modernization, and has made great progress in information management [7]. Not only are enterprises the first to accept information management, but most relevant parts of the government also adopt information management, which is conducive to improving the work efficiency of the government. Although China's information management is not long, it has made great achievements in the past. Nevertheless, Xu found that compared with most of the European and American countries led by the United States and Britain, China's level of government information management is still relatively low [8]. At the same time, Gao et al. found that the economic development of various parts of China is different, which leads to the unbalanced development of government and enterprise informatization. The main performance is that emerging high-efficiency enterprises, export-oriented enterprises with the ability to explore the international market and large- and medium-sized state-owned enterprises are developing rapidly, while small- and medium-sized enterprises and some old enterprises without competitive strength and poor efficiency are developing very slowly [9]. In addition, He and Zhu found that enterprises are more and more aware of the importance of informatization. They clearly know that if they want to survive and develop well, they must move towards informatization. Only in this way can they improve the competitive strength of enterprises [10]. Yonghui et al. believe that the landscaping information management system integrates modern management theory, database technology, network communication technology, and computer technology to maximize the development and sharing of landscaping information management resources [11]. Huang et al. said that at this stage, China's landscaping information management has not reached a high degree of informatization [12]. The following are examples:

- (1) The overall level is not high. Compared with other industries, China's overall level of information management in the construction of landscaping is still not high, there is an imbalance in development among regions, and the investment is not high, there is no popularization, and there is a lack of corresponding standards.
- (2) Management and informatization are not fully integrated, and there is a certain disconnection. When using computers to deal with work and business, it is impossible to deal with it completely according to the actual work process. There is no good cooperation and a certain disconnection. It is difficult to correctly reflect the management and service situation. At the same time, the landscaping information management system with the characteristics of informatization still has many imperfections. First, a single system function has no way to meet the current needs of landscaping information management. Second, the landscaping information management system used in other provinces and cities is lack of universality, and there is no way to use it in every region. In addition, some information of the system cannot be shared. However, at present, the landscaping information management has begun to move towards networking, integration, and intelligence, which is conducive to improve the information level of landscaping. In the research of landscaping information management system, it has achieved certain results. But there are still many problems. Therefore, we study the design of landscaping information management system, grasp the dynamics of advanced management system at any time, absorb useful experience, and apply it in landscaping information management system in time.

3. Method

3.1. ArcObject Component Set. ArcObject component set is a series of COM component sets developed by C++ and built based on Microsoft COM technology [13]. It is the development platform of ArcMap, ArcCatalog, and ArcScene in ArcGIS family. It has an independent platform, supports obese- and thin-skinned users, and supports GIS desktop applications. Developers can design powerful and flexible applications based on ArcObject devices to meet a wide range of user needs.

In ArcGIS8.3, ArcObject is not an independent application product, but a software development package bundled in ArcGIS desktop purchased by users. In ArcGIS9.0, ESRI launched ArcGIS Engine, which enables ArcObject to be published and used as a separate product [14], as shown in Table 1.

3.2. Comparison of Secondary Development Modes Based on AO. There are many secondary development modes based

on AO, and various development modes have different characteristics, as shown in Table 2.

UML (unified modeling language) is an industrial graphics standard for object-oriented analysis and design. ArcObject's object model diagram uses UML notation.

Abstract class: cannot be used to create objects. But a description of subclasses. For example, "line" can be an abstract class of "main line" and "secondary line" [15].

Class that can be created: refers to the object that can be directly created in the development environment with object definition syntax. For example, it can be written as `dim as new < Object >` and `CreateObject < Object >` in VB.

Instantiable class: new objects cannot be created directly. However, objects of this kind can be created as properties of other classes or through the use of other classes.

In these three categories, there are several possible types of class relationship.

Associations: indicates that there is some semantic connection between two classes. Diversity is defined at both ends. For example, one field can have multiple owners, and one owner can also own multiple fields, as shown in Figure 2.

Type inheritance: defines a special class, which shares attributes and methods with its parent class and has its own additional attributes and methods [16]. For example, a primary line and a secondary line (both classes can be created) are the types of a line (abstract class), as shown in Figure 3.

Instance: describes the object of a class. One of its methods can be used to create objects of other classes. For example, an "electrode" object may have a method to create a "transformer" object, as shown in Figure 4.

Aggregation: it is an asymmetric connection, in which objects from one class are considered as a whole and objects from another class are considered as local [17]. If there are three transformers in a "transformer" bank, "transformers" and "transformer bank" are related, but after the "transformer bank" is removed, "transformers" may still exist.

Composition: a stronger form of aggregation in which objects from the overall class control the lifetime of objects from some classes. If an "electrode" object contains one or more "crossbar" objects, in this design, if the "electrode" is removed, the "crossbar" can no longer be used. The "electrode" object controls the life of the "crossbar" object, as shown in Figures 5 and 6 [18].

For the tedious GIS development work, the ideal solution is the practicability of a component-based development framework, which allows solution providers or internal developers to quickly build industry-specific GIS application software. The GIS development base should provide the necessary spatial analysis work that software applications need to complete and allow software developers to focus on the specific design needs of the software. ArcGIS Engine of ESRI company is such a GIS framework. It is created in response to the request of ESRI users. It can classify rich ArcGIS technologies by products and embed its spatial analysis function into new or existing application software [19].

ArcGIS is a group of integrated family GIS software products, which can be used to publish perfect and upgradeable GIS systems in single projects, working groups,

TABLE 1: ArcGIS Engine components.

Developer components
Map presentation
Map analysis
Data access
Base services

and enterprise projects. It is based on a common library of shareable GIS component ArcObject [20]. ArcGIS includes the following main components, as shown in Figure 7.

System management is the command and control center of the whole system platform. System management is the basis for the operation of the accounting information system. It provides public account sets, annual accounts, and other related basic data for other subsystems. The operators of each subsystem also need to set and assign functional rights in the system management. Application objects are divided into system managers and application managers. The functional structure of system management is shown in Figure 8.

Greening management is divided into query of greening object information, input of new greening information, and browsing of specific information of greening object. Among them, the query of greening object information is divided into query according to greening type information, query according to the location of greening area, query of greening object creation time cycle, and query of greening object existing maintenance status [21], as shown in Figure 9.

3.3. Measure the Accessibility Index of the Whole Network.

The average accessibility index represents the average value of the accessibility of each node in the network, which is usually used to evaluate the overall accessibility level of the traffic network, as shown in formula (1).

$$\bar{A} = \frac{1}{n} \sum_{i=1}^n A_i. \quad (1)$$

Network connectivity reflects the average number of lines connected by each node, which is the ratio of the number of lines in the network to the number of nodes in the network, as shown in formula (2).

$$\beta = \frac{\omega}{\nu}. \quad (2)$$

Network stretch is mainly reflected by network diameter and network stretch index, as shown in formulas (3) and (4).

$$D = \text{MAX}\{S_{ij}\}, \quad (3)$$

$$\eta = \sum_i \sum_j S_{ij}. \quad (4)$$

Yang Tao and others defined the accessibility of transportation network as shown in formula (5). M is the network.

$$\bar{S} = \sum_i^n \sum_j^n L_{ij} \times M_{ij} \sum_i^n \sum_j^n M_{ij}. \quad (5)$$

Spatial barrier model is based on graph theory to analyze the reachability of nodes in the network. The model defines reachability as the difficulty of overcoming barriers in space. The model is shown in formula (6).

$$A_i = \sum_j L_{ij}. \quad (6)$$

The model is simple in form and takes the spatial barrier between two nodes as a numerical index to evaluate accessibility. The calculation is convenient and the results are easy to explain, the location information of the node can be well reflected. The model is widely used in traffic network research. The disadvantage is that all nodes are treated equally and lack of consideration of accessibility factors such as land use, so it cannot accurately reflect the actual accessibility of nodes [22].

The cumulative opportunity model focuses on the difficulty of nodes approaching opportunities. Accessibility refers to the number of opportunities that can be accessed from a node using a specific mode of transportation within a certain threshold. Through a given threshold, the number of all opportunities (shopping, medical treatment, school, etc.) exposed within the threshold range is defined as the accessibility of a specific node [23]. The more the opportunities, the better the accessibility. Cumulative opportunity model is usually used to evaluate the accessibility of service facilities, as shown in formula (7).

$$A_i = \sum_j O_{jt}. \quad (7)$$

The equilibrium coefficient model is the most general spatial interaction model. Proposed the calculation method of reachability by using the direct maximum law of statistical method and gave four representative models: production constraint model, attraction constraint model, double constraint model, and unconstrained model. Among them, the most commonly used in accessibility is the double constraint model, and the formula is shown in formula (8).

$$T_{ij} = A_i B_j O_i D_j F(d_{ij}), \quad (8)$$

where, T_{ij} is the travel volume from traffic area i to j , O_i and D_j are the number of activities in traffic areas i and j , $F(d_{ij})$ is the distance attenuation function, A_i and B_j are the equilibrium coefficients, and their forms are shown in formulas (9) and (10).

$$A_i = \left(\sum_{j=1}^n B_j D_j F(d_{ij}) \right)^{-1}, \quad (9)$$

$$B_j = \left(\sum_{i=1}^n A_i O_i F(d_{ij}) \right)^{-1}. \quad (10)$$

TABLE 2: Comparison of AO secondary development modes.

Comparison items	Customize on ArcMap	VBA development	Using VB and other development tools
Degree of difficulty	Easily	Secondary	More difficult
Code workload	Small	Secondary	Large
Flexibility	Small	Secondary	Large
Program dependency	It is inseparable from application software	It is inseparable from application software	Independent program
Code existence form	Stored in MXD	Save text in MXD	Standalone EXE file
Licensing mode	Need	Need	Need

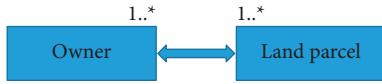


FIGURE 2: Associations.

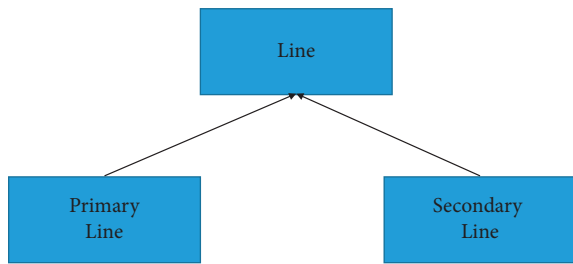


FIGURE 3: Type inheritance.

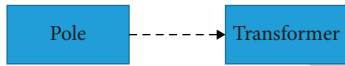


FIGURE 4: Instantiation.



FIGURE 5: Aggregation.



FIGURE 6: Composition.

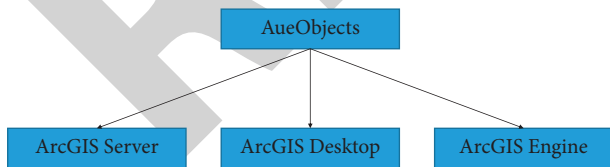


FIGURE 7: ArcObject is the basic component technology of ArcGIS products.

Potential energy model, also known as potential model and gravity model, comes from Newton’s law of universal gravitation. Hansen proposed it in 1959. It mainly uses potential index to evaluate accessibility. The general expression of the model is shown in formula (11).

$$A_i = \sum_j S_j F(d_{ij}). \quad (11)$$

A_i indicates the accessibility from zone i to all opportunity points; S_j represents the attraction of opportunity point j ; $F(d_{ij})$ represents the distance attenuation function, which is generally expressed by negative power function, as shown in formula (12).

$$A_i = \sum_j \frac{S_j}{d_{ij}^\beta}. \quad (12)$$

The potential energy model in formula (12) only considers the attraction point, but does not consider the demand point (the competition between demand points for services). By introducing the supply-demand ratio index, the different attraction points are treated in a hierarchical manner, considering the interaction between them. The improved model is shown in formula (13).

$$A_i = \sum_{j=1}^n \frac{S_j d_{ij}^{-\beta}}{V_j}, \quad (13)$$

where, A_i is gravitational accessibility, n is the total number of attraction points, S_j is the attraction of point j , and V_j is the competition intensity of service demand, as shown in formula (14).

$$V_j = \sum_{k=1}^n D_k d_{kj}^{-\beta}. \quad (14)$$

Jin Fengjun (2004) puts forward the concept of accessibility coefficient, which is defined as the total cost distance D of each node; compare the average value of the total cost distance of all nodes in the system, as shown in formula (15).

$$A_{dj} = \frac{D_i}{(\sum D_i/n)}. \quad (15)$$

Later, we uniformly expressed the accessibility coefficient, as shown in formula (16).

$$R_A = \frac{A_i}{B}. \quad (16)$$

The accessibility coefficient indicates the relative accessibility level of each node in the network. Ease of access is inversely proportional to the number of access coefficients, with the average network having the lowest coefficient.

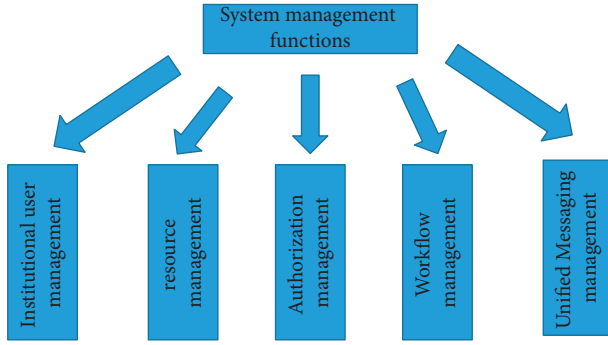


FIGURE 8: System management function structure.

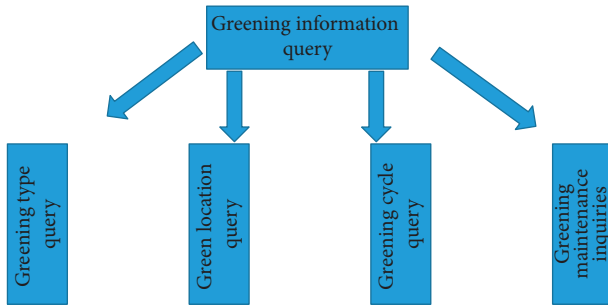


FIGURE 9: Greening management information diagram.

Relative accessibility can better reflect the change trend of node accessibility and the position of nodes in the network. Relative accessibility can be expressed as shown in formula (17).

$$RC_i = \left(\frac{A_i - A_{\min}}{A_{\max} - A_{\min}} \right), \quad (17)$$

where, RC_i is the relative accessibility value of node i , and the smaller the value, the easier it is for the node to contact with the other nodes, A_i is the accessibility value of node i , A_{\max} is the maximum value of node accessibility in the network and the minimum value of node accessibility in A_{\min} network. Accessibility coefficient and relative accessibility are usually used to standardize the calculated accessibility value, so as to eliminate the influence of dimension on accessibility evaluation.

Accessibility coefficient and relative accessibility index are mainly used to indicate the position of nodes in the whole traffic network.

Spatial accessibility measurement is carried out between the starting point and the target point. Before the measurement, the target point data should be obtained. The target point data is usually obtained by land use status map or remote sensing land use interpretation and classification. Data acquisition refers to the use of a device that automatically collects data from various data sources into one device. The collected data are various physical quantities that have been converted into electrical signals, such as temperature, water level, wind speed, pressure, etc., which can be analog or digital. The acquisition is generally a sampling

method, that is, the same point data is repeatedly collected at a certain time interval (called a sampling period). Most of the collected data are instantaneous values, but also a characteristic value within a certain period of time. Accurate data measurement is the foundation of data collection, such as Baidu map point of interest (POIs) data [24]. When using the spatial interaction model to measure accessibility, we should also consider the attraction of the target point. The selection of attraction index should be defined according to the actual problems and the characteristics of supply and demand points. The common attraction points in accessibility evaluation are social service facilities, transportation stations, urban nodes, etc., according to the investigation of urban residents' daily travel behavior, residents' visit questionnaire, etc., The attraction reference indexes of common attraction points are shown in Tables 3 and 4.

After system performance inspection, when there are more than 100 users on the platform at the same time, the response time of most of the platform operations is less than 2.5 seconds, and the resource utilization rate in the platform is less than 60%. In addition, the throughput of the platform was tested, and as the number of users of the platform increased, so did the response time of the platform. All businesses of refined urban management focus on population, housing, events, and other information, so population, housing, and events are the basic information of all work. Business development is based on these basic information, and these businesses themselves are the focus of urban integrated service management [25].

Generally speaking, the organizational structure of government departments with different functions will be adjusted with the change of management system and the revolution of management mode, but their functions (business areas) in social life are relatively stable [26]. Due to such characteristics, when building data resources, from the perspective of stability and independence, the concept of a data environment called the "subject domain model" is introduced from the standpoint of stability and independence.

The subject domain model is different from the business system domain model. They are relatively stable and oriented to the business domain. The business system domain model is a data environment for business management. With the change of management mode and process system, the definition of data resources may be adjusted, and this adjustment may occur frequently.

According to the above data analysis, the data classification and relationship of the subject domain model are shown in Figure 10.

4. Results and Analysis

The rainwater in the city will eventually enter the rainwater collection "surface" of the city, that is, the final storage site of rainwater, after the retention and absorption of the source link, the dredging, purification and peak control of the process link [27]. For the design of urban rainwater collection surface, the technical measures of urban rainwater landscape include ecological wetland, multi-functional

TABLE 3: Common attraction point data and attraction index a.

Attraction type	Attractiveness index
School	Teachers, school area, school hardware quality, etc.,
Hospital	Strength of doctors, number of hospital beds, etc.,
Market	Mall scale, number of employees, average annual profit, etc.,
Bus station	Bus station scale, average daily passenger flow of bus station, etc.,

TABLE 4: Common attraction point data and attraction index b.

Attraction type	Attractiveness index
Park	Park area, daily average number of tourists, etc.,
Enterprise	Enterprise employees, etc.,
Train station	Station scale, daily average passenger flow of railway station, etc.,
Town node	GDP, number of registered residences, etc.,

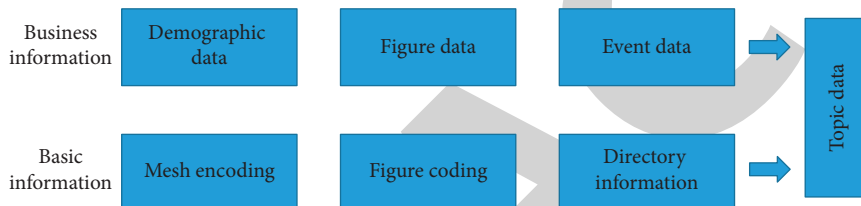


FIGURE 10: Classification diagram of subject domain model.

regulation and storage tank, landscape rainwater pond, etc., As the terminal hub of urban rainwater collection, landscape design is more important. The rainwater collection surface in the city can be reasonably set according to the distribution of “rainwater community” and the rainwater runoff in the community. As the end link of rainwater runoff, the storage function of rainwater and the surrounding landscape effect have become the key of ecological landscape design.

The collection surface control of urban rainwater mainly includes the design of rainwater wetland and rainwater lake in rainwater landscape measures [28]. When the rainwater passes through the process link of rainwater dredging, it is preliminarily purified, while the storage tank in the terminal link can purify the rainwater twice. After precipitation and purification, the rainwater in the terminal link can not only be directly used for landscape greening around the urban rainwater collection surface, but also be purified by purification equipment for domestic and sanitary water in the city.

The concept of “rainwater community” is of a great significance not only in the collection and utilization of urban rainwater, but also in the design of urban public landscape. Firstly, through the application of GIS system, we can have a more detailed and in-depth understanding of the geographical and geomorphic characteristics of the city. According to the geographical characteristics of the city, scientifically divide the “rainwater community” to make the urban rainwater landscape planning and design more targeted. Secondly, the concept of “rainwater community” puts

forward a new theoretical method for urban rainwater landscape design and provides a scientific basis for the construction of sponge city in China. In addition, in terms of building an ecological city, through the exploration of “rainwater community,” it can effectively control urban rain and flood disasters, reduce the waste of urban rainwater resources, improve the landscape environment of urban public space, and have practical value for the research of urban landscape system. Finally, the intervention of rainwater landscape can effectively improve the aesthetics and artistry of urban rainwater public facilities.

The overall terrain of the city is high in the southeast and low in the northwest, with an average altitude of about 410m. It faces the Weihe River and the Loess Plateau in the north and the Qinling Mountains in the south. Its unique geographical location has created a semi-humid continental monsoon climate with rich precipitation. The city is one of the earliest cities in human history. Its climate belongs to the semi-humid monsoon climate area in the warm temperate zone. It has moderate rainfall and four distinct seasons. The average frost-free period is 219–233 days per year. The temperature in January is the lowest, with an average of -0.5°C–1.3°C; the temperature is the highest in August, with an average of 26.4°C–26.9°C; the annual average temperature is 13.3°C. The average annual precipitation is 507.7 mm–719.8 mm. The annual average humidity is 69.6%. The average annual snowfall day is 13.8 days. Figure 11 shows quarterly average precipitation and percent annual precipitation.

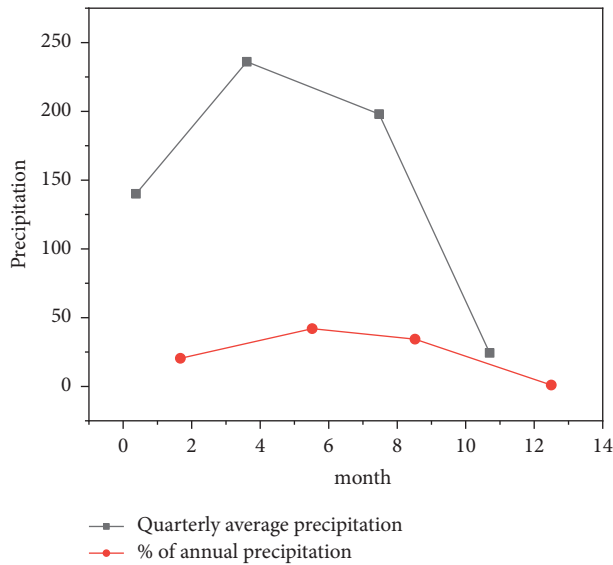


FIGURE 11: Distribution of precipitation in the city.

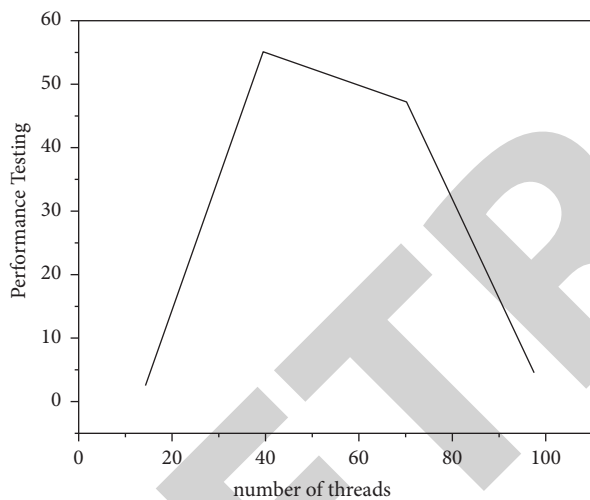


FIGURE 12: Performance test results of the system.

The urban construction has brought serious damage to the urban green space system. The massive application of impervious pavement materials has cut off the natural circulation system of urban rainwater resources and brought a series of urban rainwater problems to the city. Many economically developed countries and regions have made a lot of efforts and contributions in the design and research of rainwater landscape, and achieved certain landscape and ecological benefits. But this is far from enough. Where cities want to retain rainwater is a key issue. In the sense of ecology, the infrastructure construction of urban rainwater management and control should be integrated with the urban landscape design. The management and control of rainwater through the way of ecological landscape can not only make effective use of rainwater resources, but also play an important role in the optimization of urban environmental landscape. Scientific and

reasonable restoration of rainwater infiltration should be based on the fine analysis and cognition of urban geographic information.

With the analysis of ArcGIS software, we can find out the main catchment routes and catchment low points with different height differences in a city. Based on the elevation data analysis of a city's road system, we can also simulate the geographical characteristics of a city's road system, analyze its hydrological characteristics and draw a conclusion. According to the analysis of road elevation data, combined with the rainwater collection area in the surrounding terrain, a triangular core area in the figure is formed. This area is the main catchment area in the road system of a city, that is, the "rainwater community" analyzed in the article. By linear representation of the data, we can clearly see the distribution of rainwater collection lines of the main road system of a city, that is, the core area of linear rainwater landscape distribution.

The performance and function test process of the platform are different. During testing, the instrument measures performance and issues data recovery requests. After doing data multiple times, you can get multiple sets of performance files, allowing you to conduct scientific analysis of the platform. Because the test performance is related to many resources in the platform, it is necessary to monitor and analyze the platform through some tools, so as to meet the needs of optimizing the platform. When testing, we should also analyze the application in detail, which can help analyze the difficult problems in the code and deal with the performance defects in the platform. At the end of the performance, write a report on the test performance. Use the analysis report to write the performance status of the platform, and use it to explain and briefly explain the performance test results.

After the pressure test, the performance test results of the system are shown in Figure 12.

Concurrent testing and stress testing are two important tests of system performance testing. The number of threads mainly used ranges from 10 to 100, and the number of request cycles is 50. After testing, it is found that the performance of the system can meet the requirements of the initial design.

After testing the system performance, when the concurrent users in the platform were more than 100, the operation response time of most of the platforms was less than 2.5 seconds, and the utilization ratio of resources in the platform was less than 60%. In addition, the throughput of the platform was also tested. When the number of users in the platform increases, the response time of the platform will also increase. The performance test scenarios and test results are shown in Table 5.

Through the above tests, the management system can basically meet the basic functions and main requirements expected by the design, and the stability of the system operation has been fully guaranteed. Each function can be realized normally, and the relevant data can reach the hands of the manager in real time. Moreover, the system is easy to operate and has little difficulty in getting started. The requirements expected in advance are basically completed, and the development of the system will be completed.

TABLE 5: Performance test scenarios and test results.

Input/action	Failed transaction	Through transaction	CPU utilization	Maximum response time (%)	Average response time (s)
Concurrent operation of 10 users	0	1680	Normal	9	1.8
Concurrent operation of 50 users	1	5954	Normal	18	4.9

5. Conclusion

It is proved that the three secondary development modes of GIS based on AO are compared, and the proposed development solution can effectively solve the problem of landscape design of green city, meet people's demand for green city, make up for the shortcomings of traditional urban landscape system, and improve people's living standards. Urban landscaping system is an important part of urban ecosystem and the main body of natural components in urban ecosystem. It has ecological benefits, social benefits, and economic benefits and has a great impact on urban living environment. Therefore, green space construction has become one of the important contents of urban construction in China. At the same time, the development of GIS and its related technologies (such as database technology and network technology) also promotes the construction and development of urban landscaping system.

Data Availability

The labeled dataset 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

This work was supported by the Anyang Institute of Technology and Xingtai University.

References

- [1] P. Shan and W. Sun, "Research on 3d urban landscape design and evaluation based on geographic information system," *Environmental Earth Sciences*, vol. 80, no. 17, pp. 597–615, 2021.
- [2] T. Jiang and Z. Li, "Study on sustainable development of environmental landscape planning based on ecological civilization theory," *Arabian Journal of Geosciences*, vol. 14, no. 22, pp. 2314–2412, 2021.
- [3] H. Gu and Y. Wei, "Environmental monitoring and landscape design of green city based on remote sensing image and improved neural network," *Environmental Technology & Innovation*, vol. 23, no. 1–2, Article ID 101718, 2021.
- [4] R. Wang, "Retraction note: landscape design of rainwater reuse based on ecological natural environment: hangzhou as an example," *Arabian Journal of Geosciences*, vol. 14, no. 24, pp. 2761–2811, 2021.
- [5] J. Shan, Z. Huang, S. Chen, Y. Li, and W. Ji, "Green space planning and landscape sustainable design in smart cities considering public green space demands of different formats," *Complexity*, vol. 2021, no. 1, Article ID 5086636, 10 pages, 2021.
- [6] T. Hu and W. Gong, "Urban landscape information atlas and model system based on remote sensing images," *Mobile Information Systems*, vol. 2021, no. 10, Article ID 9613102, 7 pages, 2021.
- [7] Y. Deng, L. Xie, C. Xing, and L. Cai, "Digital city landscape planning and design based on spatial information technology," *Neural Computing & Applications*, vol. 34, no. 12, pp. 9429–9440, 2021.
- [8] Y. Xu, "Application of green building design based on the internet of things in the landscape planning of characteristic towns," *Advances in Civil Engineering*, vol. 2021, no. 3, 11 pages, Article ID 6317073, 2021.
- [9] Y. Gao, Y. Zhang, and H. Alsulaiman, "Spatial structure system of land use along urban rail transit based on gis spatial clustering," *European Journal of Remote Sensing*, vol. 54, no. sup2, pp. 438–445, 2020.
- [10] H. He and W. Zhu, "Efficient, Customizable and Edge-Based Webgis System," *Human-driven Edge Computing (HEC)*, IEEE Access, vol. 8, no. 99, p. 1, 2020.
- [11] L. Yonghui, B. Lipeng, and C. Bo, "Analysis of enterprise site selection and r&d innovation policy based on bp neural network and gis system," *Journal of Intelligent and Fuzzy Systems*, vol. 39, no. 4, pp. 5609–5621, 2020.
- [12] W. Huang, J. Ren, T. Yang, and Y. Huang, "Retraction Note: research on urban modern architectural art based on artificial intelligence and GIS image recognition system," *Arabian Journal of Geosciences*, vol. 14, no. 24, pp. 2716–2813, 2021.
- [13] X. Ding and F. Li, "Retracted article: GIS-based marine atmospheric environment and fishery company governance structure," *Arabian Journal of Geosciences*, vol. 14, no. 15, pp. 1510–1515, 2021.
- [14] J. Slavík, M. Dolejš, and K. Rybová, "Mixed-method approach incorporating geographic information system (gis) tools for optimizing collection costs and convenience of the biowaste separate collection," *Waste Management*, vol. 134, no. 9, pp. 177–186, 2021.
- [15] J. Wells, R. Grant, J. Chang, and R. Kayyali, "Evaluating the usability and acceptability of a geographical information system (gis) prototype to visualise socio-economic and public health data," *BMC Public Health*, vol. 21, no. 1, pp. 2151–2220, 2021.
- [16] N. Zainab, A. Tariq, and S. Siddiqui, "Development of web-based gis alert system for informing environmental risk of dengue infections in major cities of Pakistan," *Geosfera Indonesia*, vol. 6, no. 1, pp. 77–95, 2021.
- [17] J. Zhang, "Research on classroom teaching evaluation and instruction system based on gis mobile terminal," *Mobile Information Systems*, vol. 2021, no. 11, Article ID 9790766, 11 pages, 2021.
- [18] K. Datta and K. Gupta, "Morphometric analysis of pagla river basin, eastern India using geographical information system (gis)," *International Journal of Scientific Research*, vol. VI, no. IX, pp. 573–576, 2021.

Retraction

Retracted: Application Research of Fuzzy Control Comprehensive Model in Agricultural Economic Management

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. Huang, R. Guo, and X. Wen, "Application Research of Fuzzy Control Comprehensive Model in Agricultural Economic Management," *Security and Communication Networks*, vol. 2022, Article ID 4406336, 11 pages, 2022.

Research Article

Application Research of Fuzzy Control Comprehensive Model in Agricultural Economic Management

Juan Huang ¹, Ru Guo,² and Xiaosen Wen³

¹Department of Management Technology, Xijing University, Xi'an, Shaanxi 710123, China

²College of Science, Xijing University, Xi'an, Shaanxi 710123, China

³Business School, Xijing University, Xi'an, Shaanxi 710123, China

Correspondence should be addressed to Juan Huang; 20180161@xijing.edu.cn

Received 6 May 2022; Revised 13 June 2022; Accepted 16 June 2022; Published 30 July 2022

Academic Editor: Tao Cui

Copyright © 2022 Juan Huang et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Agriculture is the basic industry of the national economy, and the transformation of agricultural economic growth mode is of great significance to ensure the supply of agricultural products and improve the quality of agricultural products. Therefore, it is the only way to solve this problem to change the way of agricultural economic growth through scientific and technological investment, industrial structure adjustment, and other methods. Based on the fuzzy comprehensive evaluation method, this paper analyzes various factors of agricultural economic development and establishes a multilevel fuzzy comprehensive evaluation model of the development status of agricultural economic system. The stochastic frontier production function model of the fuzzy control comprehensive model is applied to decompose the agricultural labor productivity, and the counterfactual thinking and distribution method are used to analyze the influence of these factors on the evolution of provincial agricultural labor productivity differences. The value inequality decomposition method measures the contribution of each factor to the provincial agricultural labor productivity difference as well as the contribution of exogenous explanatory variables to the provincial agricultural technical efficiency difference. It is concluded that the relative contribution rate of nonagricultural activities to the difference in agricultural technical efficiency is the largest, and the average relative contribution rate reaches 74%. The improvement of agricultural labor productivity cannot rely solely on the increase in the input of agricultural material factors, but should rely on science and technology.

1. Introduction

Agriculture is faced with the dilemma of less arable land and high demand. How to grow more crops on limited land has become one of the hotly debated issues. Modern agriculture adds some automatic control equipment on the basis of traditional agriculture, which relieves the pressure of agriculture to a certain extent, but there is still great room for improvement [1]. The traditional control theory has gradually been unable to meet people's needs, and the emergence of fuzzy control theory can effectively alleviate and most likely solve this problem. Agricultural labor productivity and per capita net income of farmers are two key indicators to measure the development of agricultural economy, and there is a large contrast between provincial agricultural labor

productivity and per capita net income of farmers, indicating that the improvement of farmers' income is mainly due to the rapid development of nonagricultural economy. The development of the agricultural economy is still relatively lagging behind. If only from the perspective of agricultural labor productivity, the development of the agricultural economy still lags behind in many inland provinces. Agriculture is the foundation and lifeblood of the national economy, and the relative lag of agricultural development will be detrimental to the stable and coordinated development of the economy [2, 3]. In addition, the uncertainty of the current macroeconomic impact restricts the sustained and rapid growth of farmers' nonagricultural income. In the postinternational financial crisis period, the foundation for economic recovery is not yet solid, trade

protectionism is on the rise, and low-cost export-oriented industries in my country's coastal areas are facing structural challenges. Due to the huge pressure of adjustment and industrial upgrading, the room for continuous growth of employment positions and wages of migrant workers will be affected. In this context, studying how to speed up the improvement of agricultural labor productivity is of great significance for increasing farmers' income, curbing the widening income gap between urban and rural residents, promoting the transformation of agricultural economic growth patterns, and developing modern agriculture.

The comprehensive evaluation of fuzzy control means that by using a certain method and according to the conditions given by the problem, an evaluation coefficient is assigned to each evaluation element for evaluation and summarization, and then the optimization is made according to the evaluation results. Through systematic and comprehensive evaluation and optimization, compared with a single evaluation element, the shortcomings of each evaluation element can be identified and then improved, so that it is easier to take effective countermeasures [4]. As the fundamental concept and guideline of evaluation work, the determination of evaluation purpose is the primary condition [5]. To evaluate a certain issue, we must first determine why the evaluation is to be made, that is, what is the purpose of the evaluation, and what aspects of the elements should be evaluated on this issue. The determination of the evaluation target is usually based on the evaluation purpose of the evaluated object. The characteristics of the evaluated object in a certain aspect can usually be reflected by a certain evaluation index. A series of interrelated evaluation indicators constitute the evaluation index system [6, 7]. The evaluation index system reflects the characteristics of the evaluation object in various aspects as a whole by synthesizing the characteristics of the evaluation object reflected by each evaluation index.

Different from traditional agriculture, modern agriculture adds many control devices to the greenhouse to facilitate efficient planting of crops, while precision agriculture based on IoT technology can achieve refined management of agricultural production, save investment, and obtain agricultural economic and environmental benefits. It is an important development direction of agricultural modernization. Fuzzy control is an important branch of intelligent control. In agricultural economic cybernetics, prediction and control models with exogenous policy variables all show that agricultural economic phenomena are regarded as random phenomena, and statistical principles are used for modeling [8]. This article will point out that the total number of agricultural economic phenomena is not only random but also vague. This is because the factors affecting agricultural economic phenomena are often very complex and diverse, and various factors are often entangled together. For agricultural economic phenomena with both randomness and ambiguity, if only randomness is considered and its fuzziness is ignored, the established statistical analysis model will fail [9]. For example, an increase in national income does not necessarily increase the sales of cloth in the market, that is, there is not necessarily a purely statistical correlation

between income and cloth sales, and it is difficult to establish a statistical model at this time.

Chapter arrangement of this paper: the first chapter introduces the related research on fuzzy control theory and agricultural economic management. The second chapter introduces the theoretical basis of the fuzzy control comprehensive model in detail. The hierarchical weights of agricultural economic management are assigned in the third chapter. The fourth chapter makes a detailed analysis of each influencing factor of agricultural economy based on fuzzy control theory. The fifth chapter is the summary of the full text.

The innovation of this paper: this paper unifies the difference decomposition of the fuzzy control model, the Sharpley value inequality decomposition method, and the growth decomposition into the same analytical framework based on the stochastic frontier model to quantify the contribution of relevant factors to the difference in agricultural labor productivity. In this way, the robustness and internal consistency of the research conclusions can be ensured. Finally, this paper uses micropanel data, which reduces the loss of information when macrodata is aggregated, and can overcome the estimation inconsistency of cross-sectional data.

2. Related Work

The fuzzy comprehensive evaluation method was put forward in the early 1980s. From the single-factor comprehensive evaluation model to the multifactor and multilevel comprehensive evaluation model, the theory and methods have been continuously improved and have been widely used in various fields. There are generally the following methods for comprehensive evaluation using fuzzy mathematics: the fuzzy comprehensive evaluation model established by the compound operation of the fuzzy relation, the comprehensive evaluation model established by the fuzzy test and the fuzzy integral, the comprehensive evaluation model established by the evaluation function, and the abovementioned comprehensive evaluation model. The application of these methods provides an effective tool for fields that cannot be evaluated by mathematical methods in the past [10].

Faran and Kemal made an attempt of fuzzy control for pressure and speed control of steam engine, and the result obtained better control performance than PID control [11]. Nguen and Chan believe that the biggest feature of fuzzy control is to express the control experience and knowledge of experts as language control rules, and then use these rules to control the system. Therefore, fuzzy control is especially suitable for simulation experts to control complex, nonlinear systems whose mathematical models are unknown [12]. Yan et al. believe that fuzzy control is a macro method of system control, the core of which is the control rules described in the language [13]. Wang et al. designed the corresponding index evaluation system according to the specific content of the effect of economic growth mode transformation, and used

the comprehensive index method and discrete coefficient method to measure and evaluate the transformation effect of economic growth mode [14]. On the basis of analyzing the theory of agricultural economic growth, Cheng and López use the arithmetic index method to obtain the total factor productivity of agriculture. Based on the total factor productivity, this paper makes a quantitative description of the growth mode since the agricultural reform. From the perspective of empirical analysis, it examines the growth of various factor inputs and their contribution to agricultural economic growth and measures the status and role of scientific and technological progress in agricultural production. Then, the evolution process of agricultural economic growth mode is described [15]. According to the content of the transformation of agricultural economic growth mode, Zhang sets up an index system to evaluate the effect of the transformation of economic growth mode. On the premise of following the design principles of the index system, it starts from three aspects: factor allocation and use, factor utilization efficiency, and economic structure transformation. It is believed that multiple indicators should be used to measure the transformation of economic growth mode, which is a multi-index evaluation problem, and the weighted rank sum ratio method can be used for comprehensive evaluation [16]. On the basis of scientifically defining the connotation of the transformation of agricultural growth mode, Tang established an index system to evaluate the degree and progress of the transformation of agricultural growth mode and took the statistical data of Hebei province as an example to verify its use effect [17]. Liu et al. believe that the transformation of agricultural economic growth mode from extensive to intensive is a gradual and dynamic process. Under the premise of a given base period, the transformation reflects the relative degree of change. A method to measure the degree of transformation of agricultural economic growth mode is given: the influencing factors of the realization degree of agricultural economic growth mode are divided into productivity, material input, farmers' living standard, industrial structure, modernization level, and agricultural commodity rate [18]. Based on the research perspective of economics, within the framework of economic growth accounting and total factor productivity, Zhukov et al. analyze the unsustainability of the current agricultural development mode from the sources of economic growth, increasing factor inputs and improving productivity. The specific realization ways to transform the agricultural development mode are put forward: economical use of traditional production factors, environmental friendliness, technological progress, technological efficiency improvement, total factor productivity growth caused by human capital investment and institutional innovation factors [19]. Song et al. believes that the difficulty in expanding the average arable land has become a fundamental bottleneck in agricultural development. Fertilizer input is an important factor in increasing agricultural output. Structural adjustment coefficient has a significant impact on agricultural output. Technological progress is the most important factor in per capita output growth [20]. Wan took effective agricultural output as the research object of

agricultural labor productivity and used the above method to analyze and recognized the important influence of cultivated land, result adjustment coefficient, and technological progress on agricultural labor productivity [21]. Meng and Zhu research shows that the advantages of agricultural labor productivity are mainly due to its advantages in structural transformation and capital deepening. Structural transformation between industries and within industries, and capital deepening within and outside agriculture have improved Shanghai's agricultural labor productivity [22]. Based on the fuzzy comprehensive evaluation model, Bacalla and Vinluan analyzes the changing trend of agricultural labor productivity in a certain place according to the time series and uses the per capita arable land area irrigation rate, labor average chemical fertilizer application amount, structural adjustment coefficient, the proportion of electromechanical irrigation area to the effective irrigation area, and other indicators to construct the impact of agricultural labor. The results show that the adjustment of agricultural industrial structure, per capita fertilizer application, and irrigation rate has a very significant impact on labor productivity [23].

According to the information currently inquired, the existing multilevel fuzzy comprehensive evaluation models group various evaluation factors of complex systems, first establish a single-level evaluation model for each group, and then establish a comprehensive evaluation model for the entire system. This kind of model is not practical for farms, and each layer of the system has a similar management structure, so it is more suitable for the agricultural situation to establish a multilevel fuzzy comprehensive evaluation model according to the organizational level.

3. Fuzzy Control Comprehensive Model Theory

Everything in the world has its laws of motion, and the motion laws of some things can be modeled, simulated, and realized by existing mathematical models, but some hard-to-find laws require a lot of human and material resources. At this time, we usually use a method called "experience" to control it, and fuzzy control is a control theory based on experience. Different from the traditional precise control, fuzzy control does not establish an accurate mathematical model, but through the method of membership, the collected precise data is fuzzified by quantification factors, and the fuzzy data is subjected to fuzzy inference by fuzzy rules, and the result is obtained. The fuzzy output is finally defuzzified (precise) through the scale factor to obtain accurate control results [24]. The process is similar to how a person manipulates a piece of equipment through their own experience. Its basic control idea is shown in Figure 1.

This step may be referred to as defuzzification. To sum up, the fuzzy control process can be summarized as the following steps: compare and calculate the measured data with the given value of the system and obtain the precise value of the system input. The fuzzy input value is combined with the fuzzy rules to carry out fuzzy inference, and the fuzzy output value is obtained. The obtained fuzzy output value is defuzzified to obtain the precise value of the output control quantity, and the controlled equipment is controlled.

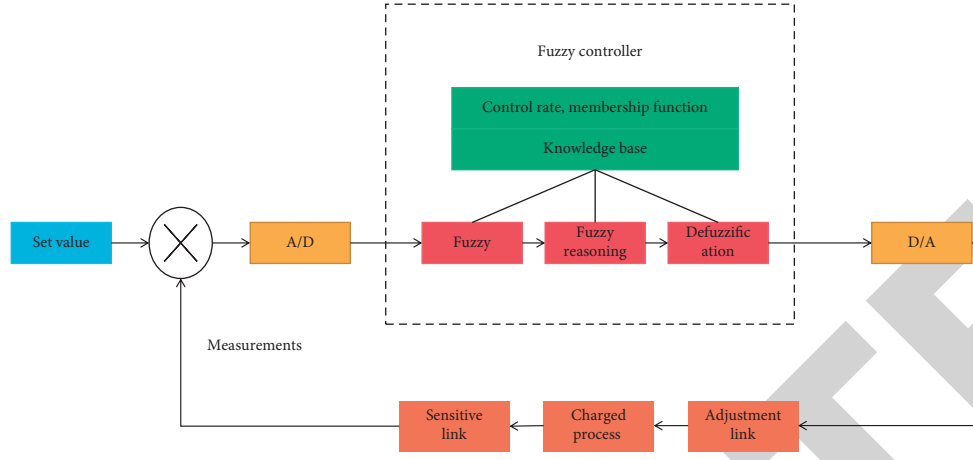


FIGURE 1: Fuzzy control principle diagram.

First, the fuzzy controller receives the parameter information of the controlled object collected by the sensor, calculates the precise value of the input variable by comparing it with the given value, and then fuzzifies the precise input value through the appropriate quantization factor to obtain the fuzzy value, that is, Fuzzy input variables of the fuzzy controller. Then it is brought into the inference engine of the fuzzy controller, and it is reasoned and analyzed in combination with the knowledge base, that is, fuzzy inference, and the fuzzy output variable of the fuzzy controller is obtained. Finally, it is defuzzified by the scale factor, that is, clear, and the precise output value of the fuzzy controller is obtained to control the controlled object. According to the above control process, it can be found that the core link of designing a fuzzy controller is to design the most ideal fuzzy rules through the knowledge base, and then determine the input and output variables of the fuzzy controller on this basis to complete the final design task. The basic composition block diagram of the fuzzy controller is shown in Figure 2.

In this paper, the advanced intelligent control technology of fuzzy control is applied in modern agriculture. If x_1, x_2, \dots, x_n is the evaluation index of the system, then the set is the set of system evaluation index, as shown in the following formula:

$$U = \{x_1, x_2, \dots, x_n\}. \quad (1)$$

Suppose y_1, y_2, \dots, y_n is the evaluation result of the system, then the set is called the evaluation conclusion set, as shown in the following formula:

$$V = \{y_1, y_2, \dots, y_n\}. \quad (2)$$

The development evaluation index of agricultural economic system varies with different regions. The main task of this paper is to analyze and abstractly reflect the common index of this kind of system. From a macro perspective, the development status of an agricultural economy can be reflected in the following four categories of indicators.

The total agricultural output value of a farm reflects the overall scale and production capacity of an agriculture. The output-input ratio of farm agriculture is an efficiency index,

which can directly reflect the level of agricultural benefits and management. The output-input ratio of agriculture can directly reflect the level of agricultural benefit and management level. The farm's per capita agricultural net income, which can reflect the agricultural development status from the microscopic level, also reflects the contribution of agricultural production to the society. The processing profit of farm agricultural products, this indicator reflects the deep processing of agricultural products and the development of agricultural industrialization to a certain extent. In the development of agricultural economy, in order to better improve its development speed and effectiveness, it is necessary to first explore the theoretical guiding role of agricultural economic management. Only by ensuring that it can provide strong theoretical guidance and point out the direction for agricultural economic development, and then can show a strong development effect.

4. Calculation Weight of Agricultural Economic Hierarchy Model Based on Fuzzy Comprehensive Theory

The commonly used production function in the fuzzy control comprehensive model analysis is simple in form, which is easy to estimate and decompose, but it is assumed that the technical level and output elasticity are unchanged. Considering the research purpose of this paper, the production function is set as shown in the following formula:

$$Y_{it} = \exp(\beta_0 + \beta_1 t) K_{it}^{\beta} \exp(v_{it} - u_{it}). \quad (3)$$

Among them, K represents the agricultural material cost input, Y represents the agricultural land area, and β represents the agricultural labor force. Agricultural material cost: this article regulates agricultural material cost input as the material cost of planting production and operation (including seed cost, seedling cost, farmyard manure discount, chemical fertilizer cost, agricultural film cost, pesticide cost, water, electricity and irrigation cost, other material cost, animal power costs, mechanical operation costs, fixed assets depreciation and repair costs, small farm implement purchase costs, labor costs, and other indirect costs), animal

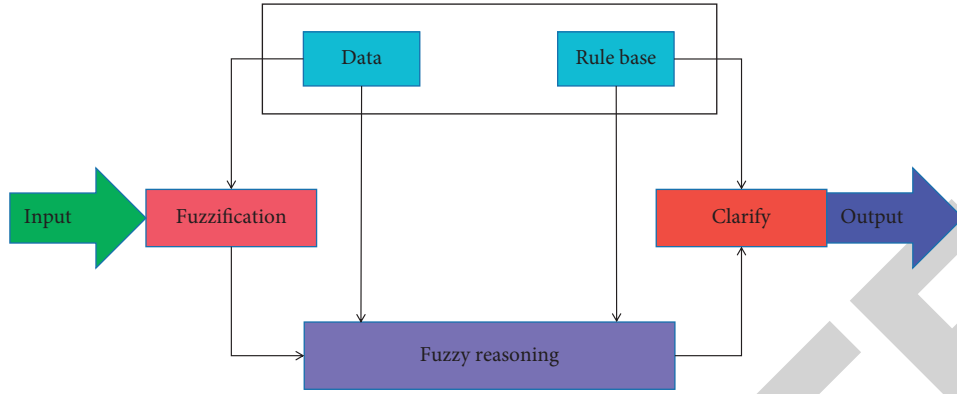


FIGURE 2: The basic composition block diagram of the fuzzy controller.

husbandry, aquaculture production, and operation costs (including young animal seedling costs, feed costs, fixed assets depreciation costs, labor costs, other production, and operation costs). This paper regards the total agricultural output of farmers as the sum of the total income of planting, animal husbandry, and aquaculture. Among them, the total income of planting industry is food crops (such as wheat, rice, corn, soybeans, and potatoes), economic crops (such as cotton, oilseeds, sugar, hemp, tobacco, and vegetables), garden crops (such as fruits). The total revenue of animal husbandry is the sum of the operating revenue of live pigs, beef cattle, mutton sheep, meat poultry, poultry eggs, and fresh milk. The total revenue of the aquaculture industry is the sum of the operating revenue of freshwater products and marine products. The agricultural labor variable refers to the number of agricultural laborers in a household.

The goal of the AHP model in this paper is to determine the strength of strength, strength of weakness, strength of opportunity, and strength of threat. The influencing factors of the strength of advantage include: the natural environment and resources are suitable for agricultural development, the foundation of social economy and traditional agricultural development is good, the characteristic agriculture develops rapidly, and the advantages of agricultural science and technology service promotion. The influencing factors of inferior power include: limited land resources, lack of high-quality talents, financial disadvantage, and small farmers' economic awareness is still relatively strong. The influencing factors of the opportunity strength mainly include: the requirements of the ecological environment, the requirements of sustainable social and economic development, the opportunities of economic globalization, and the support of national policies. The influencing factors of the threat include: the challenge of economic globalization to the development of agricultural economy, the intensification of competition in the domestic agricultural market, and the imperfection of the market economic system. The influencing factors of these subdivisions are the criterion layers.

The maximum eigenvector corresponding to the maximum eigenvalue of the judgment matrix is calculated and the weight vector of each criterion layer factor is obtained. The judgment matrix is obtained by the arithmetic mean of the scores in the valid questionnaires. The judgment matrix

and weight distribution of the influence of each factor are shown in Table 1.

In order to determine the weight of each index by AHP, it is necessary to check the consistency of the judgment matrix based on it, and define the consistency index ACLI. The calculation formula is shown as follows:

$$ACLI = \frac{\lambda_{\max} - n}{n - 1}. \quad (4)$$

Among them, λ_{\max} is the largest characteristic root of the judgment matrix and n is the order of the judgment matrix. The given average random consistency index is shown in Table 2.

Intensive growth of agricultural economy is often accompanied by large-scale capital investment, such as agricultural mechanization and precise use of chemical fertilizers. In order to realize the smooth transformation of agricultural economic growth mode, we must increase the investment of agricultural funds, strengthen the construction of agricultural economic infrastructure, and strive to improve the comprehensive agricultural production capacity. On the one hand, it is necessary to increase investment in agriculture and broaden the sources of agricultural funds. On the other hand, it is necessary to improve the use efficiency of agricultural funds. The positive role of agricultural economic management in agricultural economic development is also reflected in specific systems and policies. This institutional guarantee is also an important condition for promoting agricultural economic development. We should pay great attention to the agricultural economic management, gradually improve the agricultural economic development system, and create more ideal development conditions. The output level can be decomposed into three parts: factor input, frontier technology level, and technical efficiency, as shown in the following formula:

$$\ln Y_{it} = \varepsilon_{it} \ln X_{it} + \ln FT_{it} + \ln TE_{it}. \quad (5)$$

If $y_{it} = Y_{it}/L_{it}$ represents labor productivity, $x_{it} = X_{it}/L_{it}$ represents factor input per labor, and L_{it} represents labor quantity, labor productivity can be decomposed into four parts: labor input per factor, labor quantity, frontier technology level, and technical efficiency, as shown in the following formula:

TABLE 1: Judgment matrix of strength.

Dominant strength	Environment and resources	Economic base	Characteristic agriculture	Science and technology	Weight
Environment and resources	1	1/2	1/3	1/3	0.16
Economic base	1/4	1	2/7	8/5	0.39
Characteristic agriculture	2	4/5	1	3/4	0.22
Science and technology	2/3	5/8	3/2	1	0.31

TABLE 2: Stochastic consistency indicators.

Order	1	2	3	4	5	6	7	8	9	10
Consistency index	0.00	0.04	0.59	0.91	1.13	1.25	1.33	1.42	1.46	1.50

$$\ln y_{it} = \varepsilon_{it} \ln x_{it} + \ln s_{it} + \ln TE_{it} + \ln FT_{it}. \quad (6)$$

The second term represents the impact of changes in labor structure on output growth, and the third and fourth terms represent changes in optimal frontier technology and relative technical efficiency, respectively. The sum of the two represents the contribution of changes in total factor productivity to output growth. In order to investigate the influence of relevant factors on the distribution of labor productivity growth, the research idea of fuzzy comprehensive evaluation is used. Assuming other factors remain unchanged, construct the virtual growth of labor productivity under the combined effect of one or several factors. Assuming that other factors remain unchanged, the joint effect of different factor combinations is examined. The joint effect of factor input and technical efficiency is shown in the following formula:

$$\ln y_{it} = \ln y_{it} + (\varepsilon \ln x_{it} + \varepsilon \ln y_{it}) + (\ln FT_{it} - \ln TE_{it}). \quad (7)$$

Similarly, the virtual labor productivity growth under the action of other multifactors can be similarly constructed according to the fuzzy control theory.

5. Application Analysis of Agricultural Economic Management Based on Fuzzy Control Theory

5.1. Differences in Agricultural Labor Productivity. This paper uses fuzzy control inequality indicators to study economic problems in the field of agricultural economy and introduces these inequality indicators into the study of economic problems in the microfield to describe the current situation of agricultural labor productivity differences. Absolute disparity methods include average difference, standard deviation, dispersion, and range, but these methods cannot fully reflect the structural characteristics of regional disparities. Relative disparity analysis methods mainly include coefficient of variation, Gini coefficient, and Theil index indicators, which can reflect the structural characteristics of regional disparities in detail. In order to accurately grasp the difference and trend of agricultural labor productivity and ensure the robustness of the analysis, this paper uses three inequality indicators: Gini coefficient, Theil (0) index, and Theil (1) index to measure the difference in agricultural labor

productivity. The six-year changes in the three inequality indicators of agricultural labor productivity in the same region are shown in Figure 3.

As shown in Figure 3, the values of the Gini coefficient, Theil (0) index, and Theil (1) index of agricultural labor productivity in six years show that there is a large difference in agricultural labor productivity among farmers in six years. And in the past six years, the values of the three inequality indicators of agricultural labor productivity all showed a first decline and then an increase, and an overall upward trend. It can be seen that in the past six years, the gap in agricultural labor productivity between different farmers has experienced a process of first decreasing and then increasing, and on the whole, this gap has a tendency to widen. It also shows that this analysis of trends in agricultural labor productivity is robust and has nothing to do with which inequality indicator is chosen to measure. The distribution of agricultural labor productivity presents a bimodal feature and gradually evolves from the peak of the left high and the right low to the left low and the right high, which means that the number of farmers with low agricultural labor productivity decreases and the number of farmers with high agricultural labor productivity increases during this period. The distribution of agricultural labor productivity shifts to the right, indicating that the overall level of agricultural labor productivity has increased. The opening of the distribution of agricultural labor productivity has become larger, indicating that the difference in agricultural labor productivity among farmers has expanded.

5.2. Analysis of Influencing Factors of Agricultural Labor Productivity Growth Distribution. Based on the stochastic frontier production function model of fuzzy theory, this chapter uses counterfactual analysis to construct a virtual agricultural labor productivity growth distribution. By comparing the difference between the virtual distribution and the real distribution, it analyzes and judges the influence of various factors on the evolution of agricultural labor productivity growth distribution.

When one influencing factor changes and the other influencing factors remain unchanged, the opening of the virtual distribution becomes larger, which means that the difference in agricultural labor productivity has expanded. The peak height has changed significantly, the left peak is lower, and the right peak is higher, which means that

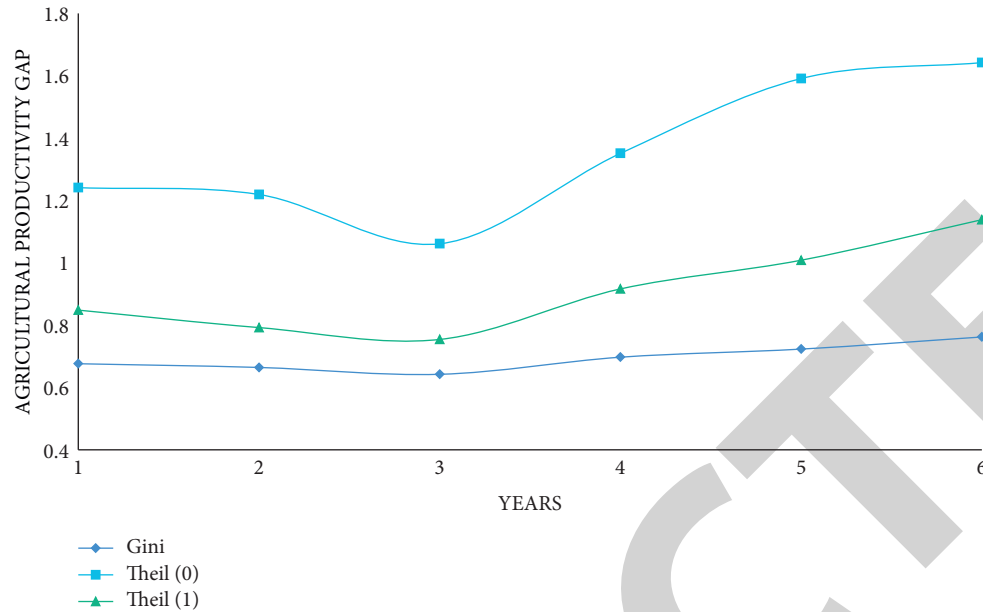


FIGURE 3: Change curve of agricultural labor productivity gap.

agricultural labor, the number of farmers with low productivity decreases, and the number of farmers with high agricultural labor productivity increases. The virtual distribution shifts to the right, which means that the overall level of agricultural labor productivity increases. This shows that the agricultural material cost input per labor is an important factor that leads to the growth of agricultural labor productivity and the expansion of differences in the past six years. However, the virtual distribution has a certain distance from the actual growth distribution in both form and location, indicating that the agricultural material cost input per labor is not the only factor affecting the growth of agricultural labor productivity and the widening of differences in agricultural labor productivity. Agricultural technical efficiency also has a greater impact on the location and shape of agricultural labor productivity growth, as shown in Figure 4.

Compared with the actual growth distribution, the virtual distribution shifts to the right and shows a unimodal characteristic, which means that the agricultural technical efficiency has improved the overall level of agricultural labor productivity, promoted the increase in the number of farmers with moderate agricultural labor productivity, and alleviated the polarization of labor. However, the impact on the widening of differences in agricultural labor productivity is not as significant as the input of agricultural material costs per labor. This shows that agricultural technical efficiency is also an important reason for the growth of agricultural labor productivity. The land area per labor and the number of agricultural labor hardly change the location and shape of the actual difference distribution, which means that the two are not the main reasons for the growth of agricultural labor productivity and the widening of agricultural labor productivity differences.

5.3. The Combined Effect of Two Factors. The combined effect of agricultural material cost input per labor and agricultural technical efficiency is shown in Figure 5.

Not only does the distribution change in shape, it also moves substantially in position and is very close to the actual growth distribution. This shows that the combined effect of these two factors has a great impact on agricultural labor productivity: first, the two-factor effect causes the number of farmers with low agricultural labor productivity to decline and the number of farmers with high agricultural labor productivity to increase. Second, the two-factor effect has greatly improved the overall level of agricultural labor productivity. Again, the two-factor effect has led to the expansion of agricultural labor productivity differences.

The combined effect of agricultural technical efficiency and land per labor is shown in Figure 6.

These virtual growth distributions all show the characteristics of “single peak.” It shows that these two-factor effects have a significant impact on the distribution of agricultural labor productivity, which means that the two-factor effect of agricultural technical efficiency can improve the overall level of agricultural labor productivity, and can increase the number of farmers with moderate agricultural labor productivity. The combined effect of frontier technology and agricultural technology efficiency has an extremely important impact on the shape of the growth distribution of agricultural labor productivity, making the “bimodal” distribution completely transformed into a “unimodal” distribution. The effect of the expansion of differences in agricultural labor productivity is not obvious, which shows that although the combined effect of the two cannot greatly improve the overall level of agricultural labor productivity as much as the input of agricultural material costs per labor, it is of great significance for narrowing the differences in agricultural labor productivity. Figure 7 shows

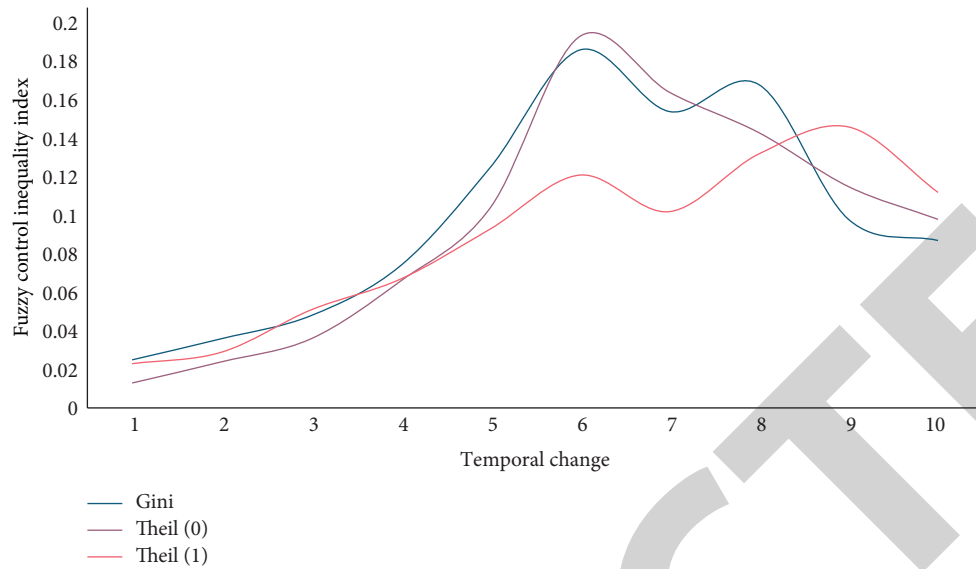


FIGURE 4: The impact of agricultural technical efficiency on agricultural economy.

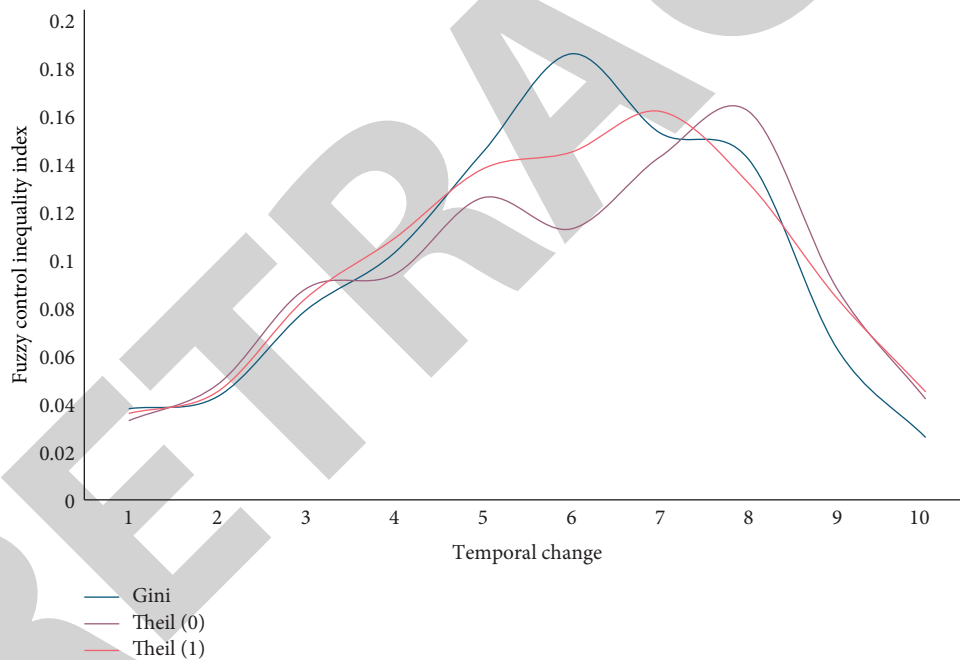


FIGURE 5: Agricultural material cost input per labor and agricultural technical efficiency.

the joint effects of cutting-edge technologies and land area per labor.

It can be seen from the figure that there is a certain difference between the two distributions of the combined effect of the number of agricultural labor forces and the actual growth distribution, and there is no evolution to the shape and displacement direction of the actual growth distribution. It shows that the combined effect of the two factors not only cannot promote the improvement of agricultural labor productivity, but also increases the number of farmers with low agricultural labor productivity. Compared with the actual growth distribution, its distribution

shape and location have not changed significantly, indicating that the combined effect of the two factors has little impact on the growth and disparity expansion of agricultural labor productivity.

Combining the above two-factor effect analysis, it can be found that the conclusions obtained are consistent with the conclusions of the single-factor analysis, and the combination of the two factors of agricultural material cost input per labor and agricultural technical efficiency has a greater impact on the growth distribution than the single-factor agricultural material cost input per labor. The influence of factors is more obvious. For the effective promotion of

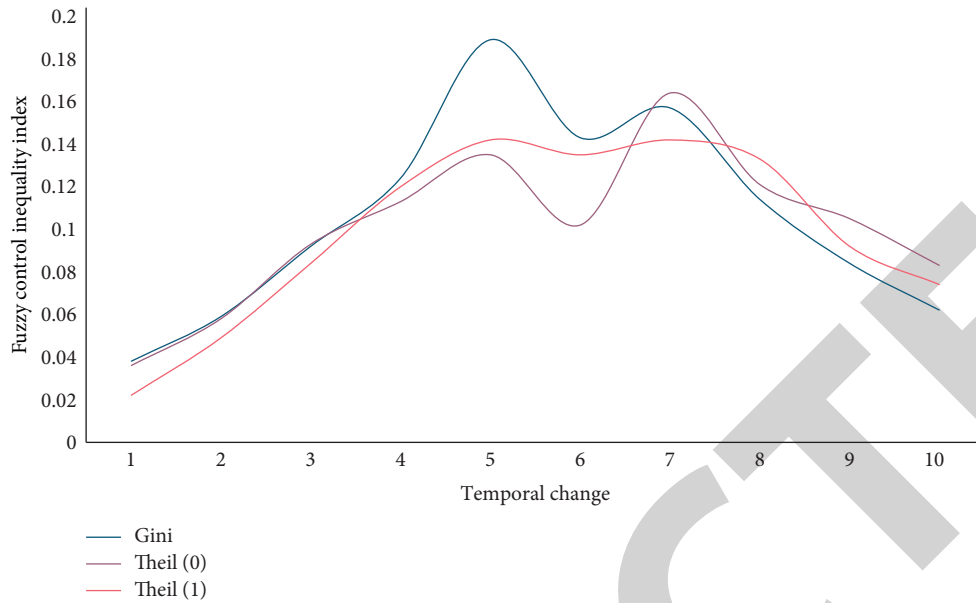


FIGURE 6: Agricultural material cost input per labor and land area per labor.

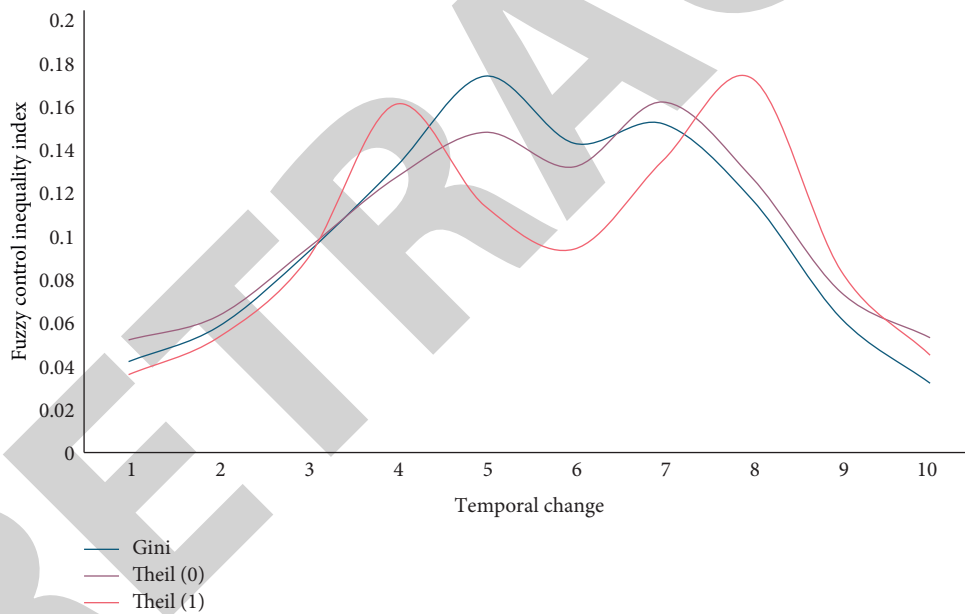


FIGURE 7: Frontier technology and land area per labor.

agricultural economic development, it also needs to be guaranteed from the institutional level. Only when the agricultural economic development system is more perfect and reasonable can the optimization and improvement of the level of agricultural economic development be better achieved. In the development of agricultural economy, the specific promoting role of agricultural economic management is not only reflected in theoretical support and policy guarantee, but also can effectively solve practical problems, gradually optimize the conditions for agricultural economic development, and ensure that agricultural economic development can be developed at a more suitable implementation in the environment.

5.4. Analysis of Influencing Factors of Agricultural Technical Efficiency Differences. From the analysis in the previous section, it can be seen that the difference in agricultural technical efficiency among farmers is the second largest factor affecting the difference in agricultural labor productivity. This section will further examine the impact of related exogenous variables on the difference in agricultural technical efficiency among farmers. Agricultural technical efficiency is the ratio between observed or actual agricultural output and ideal or potential agricultural output. The size of technical efficiency reflects the effective degree of producers using existing technology, and its value is between 0 and 1. The closer it is to 1, the higher the technical efficiency. The

TABLE 3: Decomposition of differences in agricultural technical efficiency.

Years	Gini	Formal education	Nonformal education	Cultivated land	Nonagricultural activities	Random factor
1	0.192	0.009	0.022	0.011	0.147	0.007
2	0.221	0.011	0.025	0.007	0.166	0.017
3	0.193	0.012	0.030	0.008	0.132	0.016
4	0.204	0.011	0.022	0.006	0.155	0.014
5	0.205	0.009	0.021	0.007	0.169	0.004

specific values of random factors were calculated to measure the contribution of the four variables of farmers' formal education, nonformal education, cultivated land fragmentation, and nonagricultural activities to the difference in agricultural productivity. The decomposition results of agricultural technical efficiency differences are shown in Table 3.

From Table 3, it can be found that the relative contribution rate of nonagricultural activities to the difference in agricultural technical efficiency is the largest, and the average relative contribution rate reaches 74%, which is much higher than the impact of other exogenous variables on the difference in agricultural technical efficiency. This means that among the five exogenous variables of farmers' formal education, nonformal education, farmland fragmentation, nonagricultural activities, and random factors, farmers' nonagricultural activities are the most important factors that lead to differences in agricultural technical efficiency. However, nonagricultural activities have a negative effect on agricultural technical efficiency. This means that farmers with a higher proportion of nonagricultural income are more likely to ignore agricultural production, which will lead to a significant reduction in agricultural technical efficiency and widen the gap with other farmers in agricultural technical efficiency. The average relative contribution rate of cultivated land fragmentation is 3%. Among the five exogenous variables of farmers' formal education, nonformal education, cultivated land fragmentation, nonagricultural activities, and random formal education ranks fifth in the impact of differences in agricultural technical efficiency. The reason may be that there is a problem of missing data in the sample data or it may be that the difference in the number of plots between farmers is not large. When the agricultural infrastructure and the degree of agricultural mechanization are relatively close, the situation of land management is also relatively similar, so it is impossible to give the results. Differences in agricultural technical efficiency have significant effects.

6. Conclusions

Using the stochastic frontier production function of fuzzy control theory, this paper decomposes the agricultural labor productivity of farmers into five parts, namely agricultural material cost input per labor, land area per labor, agricultural labor force, agricultural technical efficiency, and frontier technology. Using the Shapley value inequality decomposition method to decompose the difference in agricultural labor productivity, the contribution and importance order of each influencing factor to the difference in agricultural labor

productivity are obtained. Using the same decomposition method, this paper decomposes the difference in agricultural technical efficiency. The contribution and importance ranking of each exogenous explanatory variable to the difference in agricultural technical efficiency is obtained. Farmers' agricultural technical efficiency promotes the improvement of provincial farmer's agricultural labor productivity, which is one of the influencing factors for the expansion of provincial farmer's agricultural labor productivity differences, and farmers' agricultural technical efficiency differences are most affected by nonagricultural activities. The farmer's agricultural technical efficiency increases the farmer households in the province's medium-level agricultural labor productivity and improves the overall level of the provincial farmer's agricultural labor productivity.

The government should increase the support of various scientific and technological plans to the agricultural field and improve the guarantee level of the operating funds of agricultural nonprofit scientific research institutions. The publicity and promotion of agricultural science and technology is an important link in the transformation of agricultural science and technology research into real productivity. This link can help farmers master new technologies, apply scientific and technological achievements to agricultural production and management, and promote family management to adopt advanced technology and production methods. Therefore, it is particularly important to strengthen grass-roots agricultural technology extension services. In the construction of the agricultural science and technology extension service system, it is necessary to base on rural cooperative economic organizations, and encourage the participation of agricultural scientific research, education and other units, agriculture-related enterprises and intermediary agencies. According to the different conditions of various places, a comprehensive agricultural technology promotion station or an industrial station can be established, and agricultural technicians can also be dispatched to townships to provide scientific and technological publicity and promotion services.

Data Availability

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

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Retraction

Retracted: The Validity of Marketing Strategy of Tourist Attractions Based on Experiential Marketing

Security and Communication Networks

Received 19 September 2023; Accepted 19 September 2023; Published 20 September 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

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.

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] M. Song, T. Niu, L. Wang, and X. Wang, "The Validity of Marketing Strategy of Tourist Attractions Based on Experiential Marketing," *Security and Communication Networks*, vol. 2022, Article ID 1825171, 10 pages, 2022.

Research Article

The Validity of Marketing Strategy of Tourist Attractions Based on Experiential Marketing

Mei Song ¹, Tianjiao Niu,² Linna Wang,^{2,3} and Xiaoyi Wang ^{1,2}

¹Qinhuangdao Vocational and Technical College, No. 90, Lianfengbei Road Beidaihe District, Qinhuangdao City, Hebei Province 066100, China

²Jeonju University, 303, Cheonjam-Ro, Wansan-Gu, Jeollabuk-Do 55069, Republic of Korea

³Langfang Normal University, No. 100 Aiminxidao, Langfang City, Hebei Province 065000, China

Correspondence should be addressed to Xiaoyi Wang; sooyisoo@qvc.edu.cn

Received 22 May 2022; Accepted 24 June 2022; Published 26 July 2022

Academic Editor: Tao Cui

Copyright © 2022 Mei Song et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

With the development of economy, people's demand for travel is also increasing. They are no longer satisfied with the single standardized travel products of travel agencies and begin to pursue personalized. When many customers travel, the most important thing is their subjective feelings. This is also the focus of tourism enterprise research. Therefore, introducing experiential marketing into tourism and realizing experiential marketing can enhance the sense of experience of tourism, improve the economic benefits of tourism, and promote the development of tourism. This paper mainly studies the application of experiential marketing in tourism industry. In this paper, based on the tourism situation of Qingyan Ancient Town and the tourism marketing activities of other tourist attractions, combined with my own design, we developed an optimized design scheme of experiential marketing. In the process of implementation, there are still areas to be improved, and the author will continue to study and learn from the sharing of other scholars. The purpose of this paper is to study the validity of marketing strategies of tourist attractions based on experiential marketing. On the one hand, the research of this paper can enrich the theory of experience marketing; on the other hand, it can also provide reference for the reality of tourism marketing, which has theoretical and practical significance.

1. Introduction

Experiential marketing in various industries has a very wide range of application of the tourism industry itself have the features of the experience, so will experience marketing in tourism is a very perfect union, let the customer from the senses, thinking, emotion, action, and so on, experience tourism products, deepen the impression of tourism products, more can achieve spiritual enlightenment [1]. To enhance the survival value and development space of tourism products, which are also what tourism enterprises want to see, experiential marketing is very important for tourism, but the application of experiential marketing in tourism is still not very perfect, which needs further improvement [2].

Experiential marketing refers to the behavior of selling a series of products by allowing customers to participate in the

sales process and experience the functionality of the products themselves, reflecting the advantages of selling products by comparing different products. In the era of comprehensive customer experience, experiential marketing not only requires a deep and all-round understanding of users but also condenses the all-round experience and respect for users on the product level, so that users can feel respected, understood, and considerate [3].

Through the means of seeing, listening, using, and participating, experiential marketing designs a scenario in which consumers produce and complete consumption in a compound feeling state by taking advantage of consumers' senses, emotions, thinking, actions, and associations and combining with their rationality [4]. Different from the traditional view, experiential marketing changes consumers from a completely rational group to a group of rational and

emotional coexistence, and summarizes that the key point of enterprise marketing should lie in the whole process of consumer consumption experience, that is, before, during and after consumption [5]. For example, the selling value of tea is very low according to agricultural products [6]. If it is sold as a gift, the price will increase several times, but when it is sold in teahouses with services, the price will increase dozens or even hundreds of times. The work of experiential marketing is exactly to solve the transformation of tea from farmers to Gongfu tea and maximize the benefits [7].

The purpose of this paper is to study the validity of marketing strategies of tourist attractions based on experiential marketing [8].

First, the author analyzes the micromarketing environment of Qingyan Ancient Town tourism and analyzes the macroenvironment of Qingyan Ancient Town tourism by using PEST analysis method. The advantages and disadvantages of Qingyan Ancient Town tourism are carefully analyzed [9]. At the same time, using the five modules of experience marketing—sensory marketing, emotional marketing, thinking marketing, action marketing, related marketing—Qingyan Ancient Town tourism current experience marketing is analyzed and summarized. Through the questionnaire, this paper analyzes the effect of experience marketing in Qingyan Ancient Town. Finally, the author uses the experience marketing SEMs strategy to optimize the tourism experience marketing strategy of Qingyan Ancient Town [10]. Combining the theory of experiential marketing with the actual situation of Qingyan Ancient Town tourism, a series of experiential marketing activities are designed for Qingyan Ancient Town tourism [11].

On the one hand, the research of this paper can enrich the theory of experience marketing, on the other hand, it can also provide reference for the reality of tourism marketing, which has theoretical and practical significance [12].

2. State of the Art

Erik Cohen, a famous Israeli tourism sociologist and scholar of tourism sociology, put forward his own views in Chapter 3, Phenomenology of Travel Experience, the first chapter of *An Overview of Tourism Sociology*. People always desire different modes of travel experience. Travel means different things to different people. Tourist experience can be roughly divided into five different types, namely recreational, experiential, experimental, transference, and existence. The essential element of tourism is the pursuit of “novelty” and “change” [13]. These two words, though we have used them indiscriminately so far, have a slight but important difference in meaning. “Novelty” refers in principle to the novelty of seeing or experiencing it for the first time, and “change” does not necessarily mean total novelty [14].

The research on tourism experience marketing started late in China. In 1999, Professor Xie Yanjun put forward the view that the core of tourism is experience, which opened a precedent for China’s tourism experience marketing.

Tourism experience marketing refers to tourism-related enterprises, in order to meet the experience needs of tourists, relying on tourism products, to provide tourists with

sensory, emotional, action, thinking, and related experience [15].

In 2004, Wei Shihua elaborated that tourism experience products should be designed according to the differences of different senses in tourism experience [16].

In 2006, Professor Xie Yanjun wrote research on *Tourism Experience: A Phenomenological Perspective*, the process of tourism is a meaningful process with interlaced time and space. For any person whose purpose is clearly to pass through such a process in such a time and space, the process has a very complete structure [17]. The book analyzes the motivation and behavior of travel experience from the motivation of human behavior, and systematically put forward the framework, content, and method of tourism experience research [18].

In 2009, Wei Xiao’an, in his book research on the *Tourism Development of Ancient Towns and Villages in China*, elaborated that the development of ancient towns should highlight the cultural theme, and tourists’ tourism is not only for sightseeing but also for experiencing local culture [19].

In 2012, Zou Tongqian, in his book *Tourism Destination Marketing*, made an in-depth analysis and summary of typical marketing cases of domestic and foreign tourism destinations and elaborated on experiential marketing strategies, providing useful strategies for other tourism destination marketing and reference [17].

It can be seen from the research that many scholars have carried out research on experiential marketing in the tourism industry, and most scholars have analyzed the strategies of experiential marketing. Based on the above research, this paper discusses the relevant theories of experiential marketing and the strategies to apply them into reality.

3. Methodology

3.1. Overview of Experiential Marketing and Tourism Experiential Marketing

3.1.1. Experience Marketing. Generally speaking, experiential marketing refers to a special atmosphere created by the enterprise unit, through the design of a series of related activities, so that customers participate in the role play, get unforgettable memories [20]. By providing customers with experience and satisfaction, the company can realize its own value and gain profits. The main goal of experiential marketing is to create an impressive experience for the customer. Marketing is mainly redefined and designed from the perspective of customers through their senses, thinking, action, emotion, association, and other aspects.

Experiential marketing considers the consumption of customers, that is, the experience of customers in the process of consumption. Customer experience comes from a certain experience of the feeling, the heart and the thought of the touch, it links the enterprise, brand and the customer’s way of life, gives customers individual actions and purchase time more extensive psychological feelings and social significance.

Experiential marketers not only consider the functions and characteristics of product, but also consider the needs of customers and the personal experience they get from the experience of consuming products and services. Considering how the customer feels about the entire lifestyle associated with the product is what the experience marketer really cares about.

3.1.2. Tourism Experience Marketing. In the tourism industry, the consumer demand has risen from the original tourism products to the pursuit of experience. Therefore, tourism experience marketing refers to the combination of tourism products, tourism enterprises to provide high-quality experience activities to meet the experience needs of customers.

For the development of tourism enterprises, they should actively discover the consumption needs of tourists and guide them, instead of passively waiting for tourists to have demands and then develop. Experience marketing is of great significance to the development and promotion of tourism enterprises, but it is also difficult, which is both an opportunity and a challenge. If tourism enterprises cannot adapt to the changes of marketing rules and meet the consumption demands of tourists under the development of society, they will eventually fail to survive for a long time. Therefore, tourism enterprises should integrate the concept of experience marketing into their guiding ideology, develop experience activities and products in an all-round way, and improve their core competitiveness, as seen in Figure 1.

3.2. Experience Marketing in the Application of Tourism Advantages

3.2.1. Enrich the Theory of Tourism Marketing. At present, most tourism marketing is still marketing in other industries methods and theories to avoid blind imitation in many places that are inflexible and flexible, so the development of the tourism industry is very slow, and therefore, the experiential marketing in tourism just inspired tourists demand for tourism process experience, complying with the new situation of tourism development, making the tourism enterprise own marketing theory to enrich.

3.2.2. To Meet the Experience Needs of Customers. The service of tourism is to let customers experience, and experiential marketing is to design a series of activities to deepen the experience, so that tourists get more impressive precious memories, deeply touched the spiritual needs of tourists.

3.2.3. Promoting Healthy Competition in Tourism. Feeling is not able to imitate the experience, and it belongs to the spiritual level of intangible products. Even looking at the same experience from the surface, different locations, different time, different climate, different characters, feeling is completely different to the tourists, so if you want to improve the competitiveness of tourism enterprises, cannot blindly imitate the experience form. Instead, they should

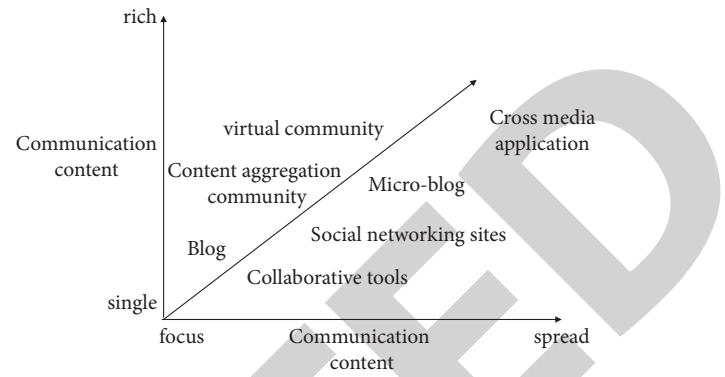


FIGURE 1: Influence relationship of tourism enterprises.

develop their own unique experience activities with their own tourism products and equipment to create a sense of experience that others cannot imitate. Therefore, tourism enterprises carry out healthy competition because of experience marketing and expand the development space of tourism enterprises.

3.2.4. Enhance the Development Potential of Tourism Enterprises. The application of experience marketing requires a lot of professional design, including the use of modern technology for data collection, data processing, and data analysis, including aesthetics, communication, advertising, and other fields. More importantly, for the study of tourists' consumption psychological activities and behavior, a deeper research in these fields is needed, the more the potential for experiential marketing can be improved.

3.3. Tourism Experience Marketing Model. The most notable feature in destination marketing with new media is that the direct influence of national and local tourism organizations on tourists from source countries and other regions of the country has been greatly strengthened and occupies an important position. Figure 2 shows the main marketing of tourism destinations in the context of new media.

3.3.1. Entertainment Marketing. Entertainment marketing means that tourism enterprises should attract tourists skillfully by creating entertainment experience and urge tourists to purchase tourism products for experience. During each tour, tourists expect to have a pleasant and unforgettable memory, rather than simply taking photos to see the scenery, getting on the bus to sleep, and getting off to see the temple, so entertainment marketing is very important in the tourism industry.

For example, forest parks in some cities are popular places for people to travel for leisure not only because of convenient transportation and preferential ticket prices but also because of the entertainment items in forest parks, such as self-service barbecue, human CS, boating, and so on. Such entertainment projects are no longer the marketing idea of simply looking at the scenery, but to let tourists blend into the nature and pursue pleasant experience, so as to relieve work pressure.

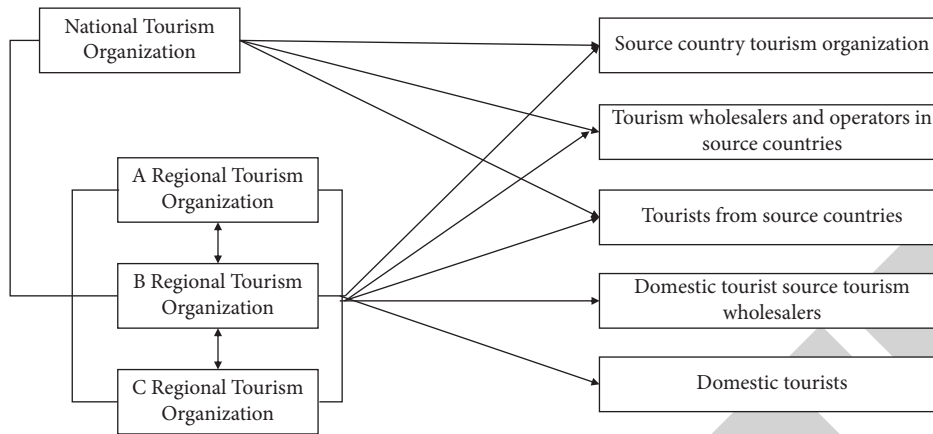


FIGURE 2: The main model of tourism destination marketing under the background of new media.

3.3.2. Aesthetic Marketing. Aesthetic marketing mainly refers to the use of beautiful elements such as color, music, pattern, and shape by tourism enterprises, as well as beautiful styles such as conciseness, luxuriousness, elegance and fashion, and the theme of beauty to strengthen the visual stimulation of tourists, cater to the aesthetic taste of tourists, and stimulate tourists to buy. Tourism products based on natural resources that are prominent in aesthetic marketing are used to design themes with individual styles through a series of external designs, so that tourists can obtain very good aesthetic experience.

3.3.3. Emotional Marketing. Emotional marketing is a very humanized marketing. It carefully observes and feels the feelings and emotions of tourists, arouses the emotional resonance of tourists through a series of experiences, and then stimulates the purchasing power of tourists. Emotional marketing can be designed from happiness, sorrow, and joy to love, hate, and hatred. For example, some revolutionary martyrs' graveyards and places where revolutionary great men once lived belong to the tourism industry of emotional marketing. People can feel the hardships experienced by revolutionary martyrs by traveling to these places.

3.3.4. Lifestyle Marketing. Lifestyle marketing is mainly based on the lifestyle desired by tourists, and a series of tourism experience activities are designed to stimulate tourists to buy. For example, in recent years, the very popular rural tourism is a very typical lifestyle marketing, which can not only enjoy the food but also feel the simple lifestyle of farmers.

3.3.5. Atmosphere Marketing. Atmosphere marketing is mainly in some specific places and environments, through the style positioning of tourism products, to create a pleasant, nostalgic, or other atmosphere to achieve the purpose of marketing through the specific atmosphere to make tourists linger. For example, museums in some cities often have unique historical relics of the city. With different

styles and interpretation by commentators, they unconsciously blend into such an atmosphere.

3.4. Five Elements of the SEMs Module

3.4.1. Sensory Marketing. The appeal goal of sensory marketing is to create the feeling of perceptual experience. It conveys information through vision, hearing, touch, taste, and smell, and tries to establish the unique image of the enterprise brand by leaving profound sensory experience to customers so as to encourage them to buy. Starbucks is a good example of sensory marketing. Wherever you are in a Starbucks, you experience a new way of life through your senses. From its living-room decor to its carefully chosen decorations and light fixtures, the sizzle of coffee, the snapping of the ground as it is brewed from the filter and the rustle of coffee beans as they are scooped out with a metal spoon, are familiar and comfortable sounds that evoke a "Starbucks feel."

3.4.2. Feel Marketing. Emotional marketing appeals to customers' internal feelings and emotions. The goal is to create emotional experience, which can range from a mild and tender positive mood to joy, pride, or even intense excitement. The operation of perception marketing requires a true understanding of the stimuli that trigger certain emotions and enable consumers to naturally become infected and integrated into the situation, as seen in Figure 2. Singapore Airlines has created a new take-off experience with the theme of bringing happiness to passengers. The company sets strict standards for how stewardesses smile and produces happiness manuals that dictate what kind of music and situations to "create" happiness. By providing excellent customer service, Singapore Airlines has become one of the top ten airlines and the most profitable airline in the world.

3.4.3. Think about Marketing. Thinking about marketing appeals is that intelligence arouses customers' surprise and interest in creative ways and creates cognitive and problem-

solving experiences for customers by concentrating or dispersing thoughts on problems. The thinking activity scheme is widely used for high-tech products. The apple computer sold 10,000 units in six weeks and was named product of the year by *Business Week*. The success of The Company is largely due to a thinking marketing program. Using “Think differently” as the slogan and combining “creative geniuses” from many different fields, the project has been featured in print ads on billboards, wall ads and buses. While the AD encouraged consumers to think about what made Apple different, it also encouraged them to think about what made them different and what made them entrepreneurial geniuses by using Apple.

3.4.4. Action Marketing. The goal of action marketing is to influence the physical experience, lifestyle, and activities of the body. Action marketing enriched customers’ lives by adding to their physical experience by pointing out alternative ways of doing things, lifestyle expectations, and interactions. While the change of customers’ lifestyle is inspired or spontaneous and may also be caused by the role of idols such as movies, videos, singers, or famous athletes. Such was the case with the promotion of drinking milk in the United States in the 1990s. The advertising agency used a large number of famous people—including supermodels, actors and actresses, and sports stars—all sporting “milk beards.” Each AD thus subtly Bridges the gap between celebrity and the benefits of milk. The celebrities involved in the campaign have designed different sectors of society to target different consumer groups with a new way of life and inspire people to act for change.

3.4.5. Relationship Marketing. As shown in Figure 2, relationship marketing includes sensory, feeling, thinking, and action marketing. Relationship marketing goes beyond personal feelings, personality, and individuality plus “personal experience” and is associated with an individual’s ideal self, others, or culture. The appeal of connected marketing is that individuals who are related to self-improvement, such as those who want to be their “ideal self” in the future, desire to be liked by others. To associate with a broader social network, a subculture, a group, etc., to establish personal preference for a brand and to allow people who use the brand to form a group. Harley is an outstanding relationship marketing brand. Harley is a lifestyle from the bikes themselves, Harley-related merchandise, to Harley tattoos on enthusiasts’ bodies consumers see Harley as part of their own identity.

3.5. Establishment of BP Neural Network Model of Marketing Strategy Combination. The marketing strategy combination of “4Ps” proposed by Eugene J. McCarthy, are namely: (1) product; (2) price; (3) sales channel (place); (4) promotion (promotion). Philip Kotler (Philip Kotler) added two “Ps” on the basis of “4Ps,” namely political power and public relations to determine the market influencing factors, using the function expressed as follows:

$$S_{ij} = \varphi(P_{ij}^1, P_{ij}^2, P_{ij}^3, P_{ij}^4, P_{ij}^5, P_{ij}^6). \quad (1)$$

Choice of excitation function. The excitation function is used to perform functional operation on the summation results of neurons in each layer to obtain the output of each neuron, which is the second process of neuron signal processing. For a multilayer neural network, the division of the region by the sigmoid function (i.e.) is completed by a region composed of a nonlinear hyperplane, which is a relatively soft and smooth arbitrary interface, so its classification is more accurate and reasonable than linear division. This kind of network has better fault tolerance. Another important feature is that it is continuously differentiable, which can be calculated strictly by using the gradient method, and its weight learning analytical formula is very clear. Therefore, this paper chooses the sigmoid function, as shown in Figure 3.

The operation of the network. For a neural network with L layers, record the output of any node i as Q_i , for the input of the p -th node of the input layer, the output of the i -th node of the $l-1$ th layer is $O_{ip}^{(l-1)}$, then j is the node of the layer, and l -th is the input to the node:

$$\text{net}_{ij}^{(l)} = \sum_{i=1}^{n_{l-1}} W_{ij}^{(l)} gO_{ip}^{(l-1)}, \quad (2)$$

where $W_{ij}^{(l)}$ is the connection weight from the i -th node in the $l-1$ layer to the j -th node in the l -th layer. The output of the j -th node in the l -th layer is

$$O_{ip} = f^{(l)}(\text{net}_{ij}^{(l)}). \quad (3)$$

About the Error Energy Function. The error energy function of the BP network is

$$E_p = \sum_{i=1}^n \phi(e_{i,p}) = \frac{1}{2} \sum_{i=1}^m (y_{i,p} - y_{i,p})^2. \quad (4)$$

Normalize the data to be between 0 and 1 and determine the expected output value. Calculate the actual output value of the neural network layer by layer where x_{\min}, x_{\max} is the maximum and minimum values of the calculated output data, respectively, and is the calculated output value. Calculate the actual output value of the neural network layer by layer.

$$y_j = f \left[\sum_{i=1}^n w_{ij} x_i - \theta_j \right], \quad (5)$$

$$z_k = f \left[\sum_{i=1}^n w_{ik} x_i - \theta_k \right].$$

Starting from the output layer, the weights are adjusted in reverse, and the formula consensus is as follows:

$$W_{jk+1} = W_{jk} + \eta \delta_k V_j, \quad (6)$$

$$W_{ij+1} = W_{ij} + \eta \delta_j V_i,$$

where

$$\delta_k = (Z_k - Z_k) Z_k (1 - Z_k), \quad (7)$$

$$\delta_j = y_j (1 - y_j) \sum_{k=0}^{L-1} \delta_k W_{jk}.$$

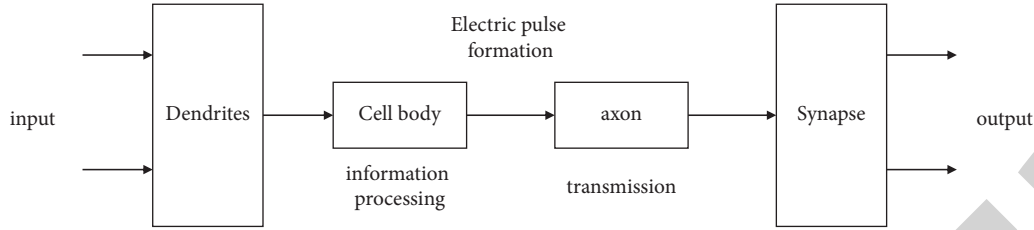


FIGURE 3: Single neuron structure model.

Calculate the total error E , if $E \leq \epsilon$, then the learning stops, otherwise, recalculate. In the actual design of the network, if the step size is small, the learning speed will be slow, and if the step size η is too large, the network will oscillate. To solve this problem, a momentum α ($0 < \alpha < 1$) can be added, namely,

$$\begin{aligned} w_{ij+1} &= w_{jk} + \eta \delta_k y_j + \alpha \Delta W_{jk}, \\ w_{ij+1} &= w_{ij} + \eta \delta_j y_i + \alpha \Delta W_{ij}. \end{aligned} \quad (8)$$

The BP algorithm process is an iterative algorithm process, and w is adjusted in each round, and so on, until the error meets the requirements, such a good network has been successfully trained, and the comparison between the simulation results and the actual results is shown in the table. As can be seen from Table 1, the maximum error is only 0.353%, and the accuracy of the simulation is high.

4. Result Analysis and Discussion

Qingyan Ancient Town, located in Huaxi District, Guiyang, was built in 1378, the tenth year of Hongwu of Ming Dynasty, as a military fortress at that time. Qingyan Ancient Town is also one of the four major ancient towns in Guizhou Province (Zhenyuan, Qingyan, Bing'an, and Longli). It has a long history and diverse cultures, and its unique cultural deposits attract a large number of tourists from home and abroad every year.

4.1. Tourism Environment Analysis of Qingyan Ancient Town. In recent years, with the blowout development of Guizhou's tourism market, Guiyang's tourism market has been growing year by year, which provides a good foundation for the development of the tourist source market of the ancient town. In 2013, the tourist volume of ancient town has exceeded 3.5 million person-times. The number of domestic tourists in Qingyan Ancient Town has been rising rapidly since 2008. The number of foreign tourists is small, only 12,000 in 2006, although the base is small, but the annual growth is very large.

Better regional conditions: traffic travel decisions that the people make influence tourism resources conditions. One of the Qingyan Ancient Town is located conveniently about 18 km away from the railway station, about 40 minutes from Longdong fort airport, provincial highway can be reached easily with high speed, with good location conditions for tourism passenger flow transformation and provides convenient conditions for growth. In recent years,

TABLE 1: Comparison of simulated value and actual value of customer loyalty.

Product number	Actual value	Analog value	Error
1	0.26	0.3601	0.311
2	0.17	0.1899	0.049
3	0.07	0.6898	0.133
4	0.09	0.0915	0.084
5	0.08	0.0890	0.120
6	0.04	0.0514	0.068
7	0.07	0.0923	0.166
8	0.05	0.0603	0.353
9	0.11	0.1258	0.231
10	0.06	0.0800	0.067

Guiyang's transportation infrastructure has developed rapidly, including the rapid construction of urban link roads such as ring-city Expressway and Huaxi Second Road, which have all been put into normal use. Meanwhile, with the rapid economic growth, Guiyang citizens' consumption ability has been greatly enhanced, and their demand and investment in entertainment and leisure and other spiritual consumption areas have been greatly increased. The public is more enthusiastic about short-term popular tourism consumption such as traveling around and driving and presents a diversified and popular development trend.

Rich tourism resources: Qingyan Ancient Town has profound cultural deposits, rich folk customs, and simple architectural style, which is enough to show its advantages in cultural hardware resources. Meanwhile, the diversified cultural integration brought by different historical stages shapes its unique exploration charm. Along the transportation line, the Confucius School, Huaxi Wetland Park, Huaxi Park, and other landscapes are matched with natural tourism product routes.

The scenic spot is well known: The tourism culture of Qingyan Ancient Town is the core attraction of the current tourist group, and the annual tourist reception is nearly 4 million, which has won a good reputation for the ancient town.

Civilian consumption: Qingyan Ancient Town and its surrounding consumption items such as eating, living, traveling, shopping, and entertainment are close to the level of popular consumption. Authentic food, special snacks, ethnic handicrafts, and other distinctive features and low cost of consumption have a great attraction for individual customers and low-cost consumption teams. At the same time, the ethnic customs, diversified integration of the inside information encourages tourists to explore the ancient town origin and cultural charm.

TABLE 2: Main categories and their connotations.

Main category	Connotation	Example
D1 Travel motivation	Tourists are influenced by the image of the scenic spot and the publicity of the scenic spot and have travel ideas	Scenic publicity, scenic spot image
D2 Preparation	Did not get a better experience, all preparations before the trip	Play route, strategy equipment
D3 Core content experience	The experience brought by the main contents such as natural scenery and ecological environment in the scenic spot	Natural scenery, Ecological environment
D4 Auxiliary content experience	Experience brought by auxiliary management services such as supporting facilities	Supporting facilities, sanitation
D5 Posttour evaluation	A comprehensive evaluation of the physical and mental changes of tourists after their travel	Appropriate groups, differences in expectations

4.2. *Qingyan Ancient Town Tourism Experience Marketing Status.* Since its inception, Qingyan Ancient Town—after the Ming and Qing dynasties in 533 CE, 38 years of the Republic of China, the fighting continued till 571 CE—is a typical military town, has a significant military history culture, and the “red,” but the cultural products of mining and development are not so good, many tourists came to propylite, only know that it is an ancient Qingyan Ancient Town. I do not know that the ancient town once had extremely important military strategic significance, and I know little about the precious history and culture left to Qingyan during hundreds of years of vicissitudes. In recent years, the city wall of Qingyan Ancient Town has been renovated. The city wall looks more spectacular, has more military guards, and creates a deeper sense of military fortress. However, its connotation construction and cultural display fail to arouse the emotional resonance of tourists.

The logical relationship between categories is formed according to the connotation of the category and the internal relationship of the category, so as to establish the main category. By sorting out the 36 categories, a total of five travel motivation, travel preparation, core content experience, auxiliary content experience, and posttour evaluation are formed. Main categories are as shown in Table 2.

Sensory experience is the signal source for people to produce memory, and it is also the biggest entry point for the design of tourism products and tourist routes. Olfactory experience strategy: In the characteristic cultural exhibition activities of Qingyan Ancient Town, the activity or product that can best reflect the memory of fragrance is probably “Rose sugar production demonstration.” Visitors can not only observe the production process of delicious rose sugar but also smell the fragrance of rose sugar, which makes people immersed in the aroma of rose sugar and linger on. In Qingyan Ancient Town, there are many similar characteristic snacks to retain memories with fragrance, but these practical products are relatively single in category, lack process experience or interaction links, unable to rise from the olfactory experience to the level of cultural cognition, and the characteristic connotation cannot be interpreted.

Film and TELEVISION cultural experience: Qingyan Ancient Town has shot VR film with cultural tourism theme. The film is based on a folk tale called “Zhuangyuan hoofs.” During the Qing Dynasty, Zhao Yijiong, a student in Guizhou province, often reviewed his lessons late into the night in order to succeed in the exams. His family often

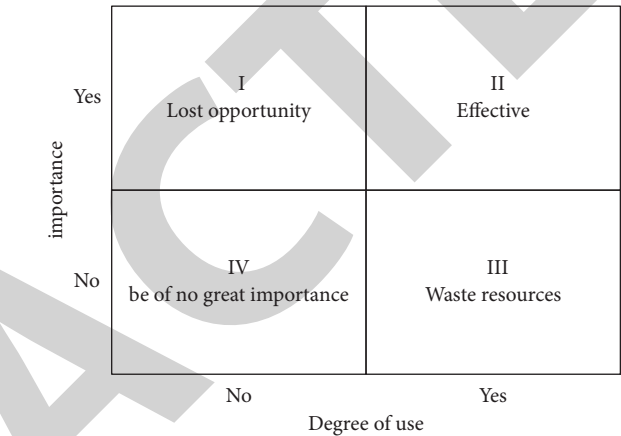


FIGURE 4: Evaluation matrix of new media marketing effects implemented in tourist destinations.

prepared pig’s feet for him to eat in order that he could have sufficient physical strength and a healthy body during the review period. Zhao Yijiong won gold list title, and there is a number of hooves this said. This film is not only full of positive energy but also full of fun. At the same time, while enjoying this VR film, audiences can enjoy and experience the intoxicating all-round beauty of Qingyan Ancient Town through VR technology.

Related experience marketing aims to enrich tourists’ travel experience and enhance their cognition by direct or indirect means, so as to stimulate participation and tourism consumption. For example, the Qingyan Ancient Town tourism VR panoramic experience has been widely spread in the mobile friend circle of Guizhou people. Tourists can see the panoramic view of Qingyan Ancient Town on Wechat, which is also a way of communication and promotion. The VR panorama experience of Qingyan Ancient Town was held at the North Square of Qingyan Ancient Town. VR has been largely applied to tourism industry in recent years; in the past, tourists before going to the scenic area, the scenic spot of relevant data, see the pictures of the scenic area, get a rough understanding about situation of scenic spot, and by VR panoramic experience not only can visitors from multi-azimuth appreciate the beauty of the ancient town, it can also give visitors a reasonable view. Avoid tourists to Qingyan Ancient Town scenic area due to carelessness or time to miss some of the attractions worth playing.

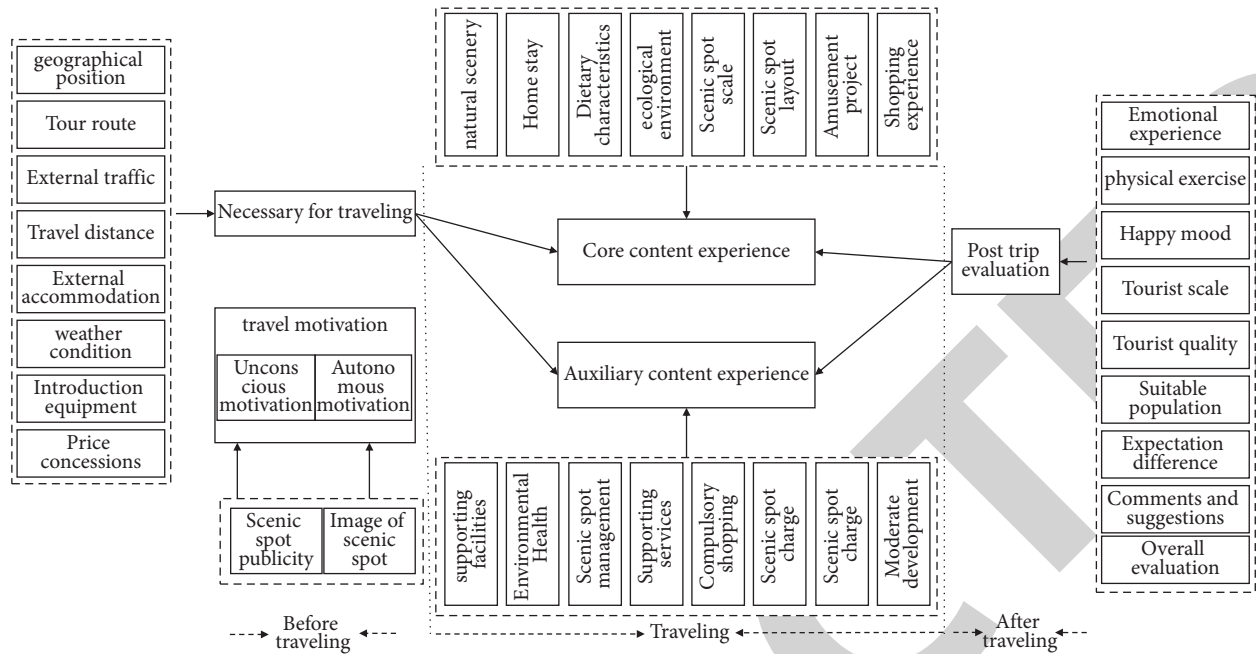


FIGURE 5: Conceptual model of influencing factors of tourist satisfaction.

4.3. Qingyan Ancient Town Tourism Experience Marketing Effect. The tourism marketing effect of Qingyan Ancient Town is analyzed from the perspective of tourism flow, as shown in Figure 4. From 2008, it received just over 1 million tourists a year, to 2014, it received more than 4 million tourists a year, the number of tourists increased nearly four times. Qingyan Ancient Town tourism marketing has achieved gratifying results in attracting tourists. The author investigated and analyzed the tourists' experience satisfaction in Qingyan Ancient Town. In order to ensure the authenticity and scientific nature of the questionnaire sample survey, the survey method of this paper is questionnaire survey of tourists on-site, and real data have been obtained. This survey conducted questionnaire survey for tourists on-site, and 200 questionnaires were collected, 188 were valid ones. The evaluation matrix of the implementation of new media marketing in tourist destinations is shown in Figure 4.

Due to the limited number of questionnaires, in order to ensure the representativeness of the questionnaire sample, 100 men and 100 women were surveyed in the questionnaire survey, and the valid number of people was 94 men and 93 women. In the survey sample, tourists between 20 and 30 years old account for the largest proportion, and the design of experience marketing strategy can take more consideration of the needs of tourists in this age group. In the sample, the educational level of tourists mainly focuses on junior college and bachelor's degree, and this group will have a relatively high demand for cultural experience. The expected stay time of the sample tourists in Qingyan Ancient Town is concentrated in half a day and one day, indicating that the ratio of tourists staying in Qingyan Ancient Town is small, which will restrict the development of accommodation in Qingyan Ancient Town. Therefore, it is necessary to consider how to keep tourists in the ancient town for a longer time.

It can be seen from the table that the mean values of most variables are low, indicating that the user experience of passengers is not good and should be further improved. The experience project of tourism experience marketing is lack of long-term: The tourism experience project of Qingyan Ancient Town is only available during festivals and will be canceled at ordinary times. Such arrangement, of course, has the consideration of its operating capital, but adverse to its long-term development. First, during the festival or statutory holidays, there are many tourists. The experiential tourism project specially developed for the festival, if not repeated attempts and adjustments, may cause adverse effects in the festival. For example, when Zhao Zhuangyuan returned to his hometown, he occasionally encountered many tourists blocking the main street. The interaction with tourists is only for tourists to take photos, and tourists cannot deeply experience the scene of Zhuangyuan returning home. Second, the short-term nature of experience marketing projects determines that these experience projects cannot really be combined with the tourism culture of Qingyan Ancient Town. Without these experiential projects that can be deeply integrated into Qingyan Ancient Town, designers will certainly not consider more far-reaching and explore the culture of scenic spots in Qingyan Ancient Town more deeply when designing. Third, short-term experiential projects can only be experienced by some tourists, while the vast majority of tourists have not experienced the information conveyed by the tourism design of the ancient town to tourists after coming to Qingyan.

Figure 5 shows the influencing factors of tourist satisfaction. Specific suggestions are as follows: Change the passenger experience project into a long-term project to avoid the excessive number of tourists during the peak period, which will affect the passenger experience. Second, experience programs should be combined with local cultural

TABLE 3: Comparison table of enterprise marketing portfolio strategy changes and market share.

Enterprise marketing mix strategy	Marketing mix factors and market share			
	Quality	Price	Sales system	Market share
Current status of company	8.5	8.5	8.5	7.91
Improve product quality	9	8.5	8.5	8.1024
Lower product prices	8.5	9	8.5	8.6364
Improve the sales system	8.5	8.5	9	8.9076
Lower prices and improve quality	9	9	8.5	8.3363
Reduce prices and improve sales system	8.5	9	9	9.3396
Improve quality and sales system	9	8.5	9	8.3107
Raise prices and improve quality	9	8	8.5	8.0538
Raise prices and improve sales system	8.5	8	9	8.6999
Reduce price, reduce quality, and improve sales system	8	8	9	8.9376
Raise prices, improve quality, and perfect sales system	9	8	9	8.4366

characteristics. Third, design experiences that most travelers can experience and accept.

Market share is an important indicator to reflect the market synthesis and concentration degree and also an important indicator to measure the competitiveness of an enterprise or a product. Scientific adjustment of marketing combination strategy is an important way for enterprises to improve their market share. To improve the market share of products, we can reduce the price, improve the quality of products and enterprises, and improve the sales system. Now take Fangtai Company as an example to illustrate its simulation results of using different marketing portfolio strategies to change its market share. The results are shown in Table 3.

The most effective way to improve the tourism market share is to reduce prices on the basis of improving the sales system. However, as the improvement of the sales network requires a large amount of capital investment, the price reduction will also affect the cash income of enterprises and cause the price war among enterprises, bringing potential threats to the development of enterprises. Therefore, what marketing strategy needs to be adopted is flexibly changed according to the actual situation of enterprises.

Specific suggestions are as follows: Change the passenger experience project into a long-term project to avoid the excessive number of tourists during the peak period, which will affect the passenger experience. Second, experience programs should be combined with local cultural characteristics. Third, design experiences that most travelers can experience and accept.

5. Conclusion

Tourism facilities are tangible, while service and experience are intangible, which is also where the real value of tourism experience marketing lies. But in the specific implementation process, there are still many deficiencies, after all, the introduction of experience marketing into tourism is still in its infancy, and marketing theory is not mature. Therefore, it is necessary to constantly combine their own characteristics and local culture design experience activities, constantly study tourists' psychology, cater to tourists' spiritual needs,

and constantly stimulate and guide tourism demand, so as to promote the development of tourism. Constantly explore and improve, and constantly tap the potential and space of tourism experience marketing.

The arrival of experience economy calls for a new marketing theory, and experience marketing arises at the historic moment. Experiential marketing will gradually replace the old marketing model, and the application of experiential marketing will be more and more extensive.

This paper uses the theory of experiential marketing to design the tourism marketing strategy of Qingyan Ancient Town. Experiential marketing meets the requirements of The Times, meets the requirements of tourism development, and more meets the experience needs of tourists.

Through the questionnaire survey, this paper found that Qingyan Ancient Town's tourism experience is not good, and its experience marketing has room for further improvement. This paper optimized design scheme of experiential marketing, combined with the status quo of Qingyan Ancient Town tourism and other tourist attractions tourism marketing activities, and the author's design has a solid theoretical foundation and abundant case, which can be used for reference of Qingyan Ancient Town tourism experience marketing in the actual implementation of the process of optimization design, and has a certain reference. However, because author's understanding of Qingyan Ancient Town tourism is not comprehensive and in-depth, the reference scenic spot and Qingyan Ancient Town tourism scenic spot have their own characteristics and differences. Therefore, this article gives the design scheme in the process of implementation, and there will always be an ascending. The author will continue to study the uniqueness of Qingyan Ancient Town tourism and actively learn from other scholars' theory. In this paper, the depth and breadth of the deepening of the efforts of Qingyan Ancient Town tourism and more experiential marketing constructive suggestions are put forward.

Data Availability

The labeled data set used to support the findings of this study is available from the corresponding author upon request.

Retraction

Retracted: Exploratory Research on the Practice of College English Classroom Teaching Based on Internet and Artificial Intelligence

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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] Y. Jia, "Exploratory Research on the Practice of College English Classroom Teaching Based on Internet and Artificial Intelligence," *Security and Communication Networks*, vol. 2022, Article ID 7133654, 9 pages, 2022.

Research Article

Exploratory Research on the Practice of College English Classroom Teaching Based on Internet and Artificial Intelligence

Yunjie Jia 

English Department, Taiyuan University, Taiyuan, Shanxi 030032, China

Correspondence should be addressed to Yunjie Jia; jiayunjie@tyu.edu.cn

Received 12 May 2022; Accepted 21 June 2022; Published 12 July 2022

Academic Editor: Tao Cui

Copyright © 2022 Yunjie Jia. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

With the rapid development of cloud computing and mobile Internet technology, the information of optional services in the network is exploding and the problem of information overload is becoming more and more serious. The recommendation system can recommend suitable English online classes for students according to their interests and needs, effectively reduce the data load, help students extract effective information from the mass of information, and make accurate recommendations. Aiming at the problems of data sparsity and cold start in the recommendation system, this paper proposes a recommendation method to improve the collaborative recommendation algorithm in college English online classroom teaching practice. Based on the extracted student tag feature information, this method uses spectral clustering algorithm to cluster similar students and transforms the original high-dimension scoring matrix into several lower-dimension subscore matrices. Then, the implicit meaning model is used to locally predict the missing score in the subscore matrix. Finally, after obtaining the missing score, the improved neighborhood-based collaborative recommendation algorithm is used to predict the global score of the target student. Experiments are performed on commonly used public data sets. Compared with the traditional recommendation algorithm, the proposed algorithm has higher recommendation accuracy and better RMSE performance.

1. Introduction

In the era of “Internet plus,” students have a broad vision, are not afraid of authority, and no longer blindly accept the indoctrination of books and teachers. The penetration of the Internet, the application of artificial intelligence, and the popularity of smart phones have also changed students’ learning concepts and ways [1]. Students’ learning input is no longer limited to classroom and relying on teachers, and they can use the abundant resources of the Internet to obtain the knowledge they need [2].

In today’s era of rapid scientific and technological development, all walks of life continue to reform and innovate and education industry is also subjected to the baptism of the tide of The Times, facing unprecedented challenges. With the continuous advancement of teaching reform in colleges and universities, innovative teaching methods have gradually infiltrated. Information-based classroom software platforms represented by university’s “Rain Classroom,” “Blue Ink Cloud Class,” and “UMU Interactive Learning

Platform” have emerged in an endless stream [3]. How to introduce the information-based classroom teaching methods under the influence of “Internet+” thinking into traditional course teaching has become the focus of teaching reform and innovation in various disciplines.

Due to the epidemic and other reasons, the demand for online teaching in universities at home and abroad has increased sharply. According to data release report, more than 2,000 colleges and universities in China have adopted online teaching tools such as Tencent Classroom and Rain Classroom for online teaching [4]. However, the Special Research Report on the Evaluation of the Effect of Online School Resumption in China in the Spring of 2020 by Imedia pointed out that the current online teaching tools in colleges and universities can only rely on teachers to recommend and release human resources and cannot integrate and utilize the teaching resources in schools automatically. Due to copyright problems, internal teaching resources can only be accessed externally by teachers and students through VPN and other ways but cannot provide good internal search and query tools.

This leads to the seemingly contradictory problem of “too many idle resources on campus and insufficient demand satisfaction,” which seriously affects the effectiveness of online teaching [5]. Although a series of new mobile Internet technologies, such as knowledge recommendation engine, have provided solutions to this problem to a certain extent, the relative isolation of resources in the campus network leads to the reduced efficiency of these solutions.

In recent years, the scale of student and English online courses in the network is getting larger, and the huge data information becomes rich resources, which also brings great challenges to the existing collaborative recommendation algorithm [6]. In the face of massive, multisource, heterogeneous, and sparse students’ behaviour data, the traditional neighborhood model-based collaborative recommendation algorithm [7] and the matrix factor-based latent factor model (LFM) are unable to do so. The traditional neighborhood-based collaborative recommendation model needs to mine the similarity information of students on the basis of calculating the similarity between all student pairs or English online course pairs, so as to determine the similar historical students of target students [8]. However, in the face of student comment information with high dimension, large scale, and sparse data substituted with context information, there is a huge amount of calculation and the efficiency of recommendation algorithm is one of the bottlenecks, affecting the further improvement of recommendation performance. Meanwhile, the problem of cold start is also one of the urgent problems to be solved in collaborative recommendation methods.

At the psychological level, domestic and foreign scholars have concluded that the individual differences of each learning individual make personalized curriculum planning have positive significance for learning [9]. Although the personalized curriculum recommendation algorithm started late in China, there are many achievements in the optimization and improvement of recommendation algorithm. Through the collaborative prediction method of learning resources in literature [10], problems such as extensibility calculation and loose calculation in collaborative recommendation algorithm are basically alleviated. Literature [11] improves the collaborative filtering algorithm based on English online courses through communication between teachers and students. By analysing the characteristics of students, a personalized recommendation algorithm suitable for students is proposed to alleviate the problem of low fit between recommendation results and learners. Literature [12] obtained and analysed the dynamic data of online learners in the learning process, extracted the personalized learning needs of learners, and made an overall course planning through professional teachers. Finally, the genetic hierarchical recommendation algorithm was used to recommend courses for learners, significantly improving the accuracy of course recommendation.

However, the above methods often involve the problem of cold start of recommendation algorithm, which makes it impossible to establish a recommendation model with good performance and accurate recommendation without initial data. This paper proposes an intelligent collaborative

recommendation algorithm based on spectral clustering and cryptic model. On the basis of mining similar information between students or items using spectral clustering algorithm, the algorithm combines the recommendation model based on cryptic meaning model with the collaborative recommendation model based on neighborhood, so as to solve the bottleneck problem in the traditional collaborative recommendation algorithm and improve the recommendation performance.

The contributions of this paper are as follows:

- (1) On the basis of obtaining the label feature vectors of students (or English online courses), the spectral clustering algorithm is used to cluster students to obtain similar students of the target students. Meanwhile, the original scoring matrix can be divided into several lower-dimension subscore matrices based on the spectral clustering algorithm
- (2) In each subscore matrix, the matrix decomposition model based on cryptic meaning model is used to locally predict the missing score to solve the data sparsity
- (3) The improved neighborhood-based collaborative recommendation algorithm is used to predict the global score of the target students

This paper consists of four main parts: Section 1 is the introduction, Section 2 is the state of the art, Section 3 is methodology, Section 4 is result analysis and discussion, and Section 5 is the conclusion.

2. State of the Art

2.1. Collaborative Recommendation Method Based on the Neighborhood Model. The neighborhood model-based collaborative recommendation method is mainly based on the user’s historical behavior information to find the nearest neighbors with similar preferences for the user. It is based on the idea of “people are divided into groups” or “things are clustered together” to recommend items that may be of interest to users. At present, many scholars at home and abroad have improved the basic nearest neighbor model in different degrees to improve the model recommendation effect [11, 13]. Literature [11] proposes a QoS-aware personalized service recommendation method based on users’ rating of service quality attributes of services. It finds near-neighbor objects with similar QoS preferences for users by building a region model. Literature [13] constructs a user preference model by mining user text comment data and extracting keyword vectors to improve the scoring-based similarity calculation in the original nearest neighbor model based on semantic information. The idea of constructing the nearest neighbor model is simple and easy to understand, but the model has poor recommendation effect for sample data sparse or cold start scenarios and does not have good scalability.

2.2. Recommendation Method Based on the Hidden Semantic Model. Compared with the neighborhood-based collaborative recommendation model, the implicit semantic model

based on matrix decomposition technique can better cope with the data sparsity problem. Moreover, it takes into account the influence of the implicit information in the scoring matrix on the recommendation effect. Literature [14] adds binarized user attributes to the implicit semantic model and uses the classification model to evaluate the importance of other user attributes and find out the similar users of the target user. Then, it combines the rating information of the target users to make predictions and recommendations. Based on the BERT model, deep nonlinear feature vectors of users and items can be extracted from the reviews, and the deep feature vectors of users and items are combined with potential hidden vectors to generate deep feature terms for predictive recommendations [15].

2.3. Collaborative Recommendation Method Based on Clustering Algorithm. The clustering algorithm belongs to an unsupervised learning method in machine learning, which can group sample data effectively. Therefore, clustering algorithms can be used in collaborative recommendation models to search for similar users of the target user. Literature [16] clusters label features to generate topic label clusters and constructs an item-topic association matrix combined with the original scoring matrix, to calculate the similarity between items. Finally, it uses a collaborative neighborhood-based recommendation model for predictive recommendation. Literature [17], on the other hand, improves the traditional recommendation model based on K-medoids clustering algorithm and probabilistic model to enhance the recommendation accuracy. By introducing a time decay function to preprocess the rating information, it proposed a collaborative recommendation model based on a clustering algorithm. Users and items are clustered based on user feature vectors and item attribute vectors, and then, an improved similarity calculation method is used to find similar users of the target user for predictive recommendation.

3. Methodology

3.1. Problem Description. Given a sample data set, each sample (p, x, r_{px}) represents a r_{px} grade for college English online course x given by student p . The sample data also contain the characteristics of student tags $[F_1, F_2, \dots, F_n]$. Each student p has a tag feature vector corresponding to it, and n represents the dimension of the tag feature vector of the student. The task of this paper is to mine the interactive information of student-student and student college English online courses from the information of student label characteristics and scoring and predict the score of target students on candidate college English online courses.

As shown in Figure 1, there are three modules. The first module uses spectral clustering algorithm to cluster students based on the characteristic vector of student tags obtained from sample data. In module 2, the score matrix is constructed in each subcluster and the cryptic meaning model based on matrix decomposition is used to locally predict missing score in each subcluster. Module 3 uses the improved collaborative recommendation model to make global

prediction recommendation. This algorithm mines similar information among students, based on the characteristic information of students' tags, and can find similar students without excessive comments, so it can solve the cold start. At the same time, the missing score is locally predicted in each submatrix in module 2, which solves the problem of data sparsity.

3.2. Spectral Clustering. In spectral clustering, all sample data are regarded as points in space and these points can be connected to form an undirected weighted graph. And, the weight of each edge is the similarity of the two vertices. The adjacency matrix can be obtained based on the similarity matrix. Then, the eigenvectors of the Laplacian matrix constructed by the sample data are clustered. In spectral clustering algorithm, there are three main methods to construct the adjacency matrix. They are ϵ -neighborhood method, k nearest neighbor method, and full connection method. In this paper, we use the symmetric k nearest neighbor method.

The KNN algorithm is used to traverse all sample points, and the k points closest to each sample point (the distance is measured by Gaussian kernel function) are taken as their nearest neighbors. It can be constructed as a symmetric adjacency matrix in the following two ways:

- (1) As long as a point is in the k nearest neighbor of another point, $m_{xy} = \exp(-(\|i_x - i_y\|_2^2/2\sigma^2))$; otherwise, $m_{xy} = 0$
- (2) Only when two points are k -nearest neighbors to each other, $m_{xy} = \exp(-(\|i_x - i_y\|_2^2/2\sigma^2))$; otherwise, $m_{xy} = 0$

3.3. Cryptic Meaning Model Based on Matrix Decomposition Technology. The implicit meaning model is derived from Simon Funk's improvement of singular value decomposition (SVD) algorithm by using gradient descent (GD). From the perspective of matrix decomposition, the cryptic meaning model decomposed the scoring matrix R into the product of two low-dimensional matrices related to student characteristics and college English online course characteristics, respectively.

$$R = UV^T. \quad (1)$$

$U \in R^{f \times t}$, $V \in R^{f \times w}$, and t and w are the number of students and the number of college English online courses, respectively. The student p 's score of college English online course x can be expressed as follows:

$$\hat{r}_{px} = \sum u_{pf} \cdot v_{xf}. \quad (2)$$

Here, u_{pf} represents the f -th eigenvalue of student p . v_{xf} represents the f -th eigenvalue of college English online course x . To obtain the parameters u_{pf} and v_{xf} , we have the following formula:

$$L(u, v) = \sum_{(p,x) \in \text{Train}} (r_{px} - \hat{r}_{px})^2. \quad (3)$$

Train is the training set. Random gradient descent, least square method, coordinate descent, and other methods can

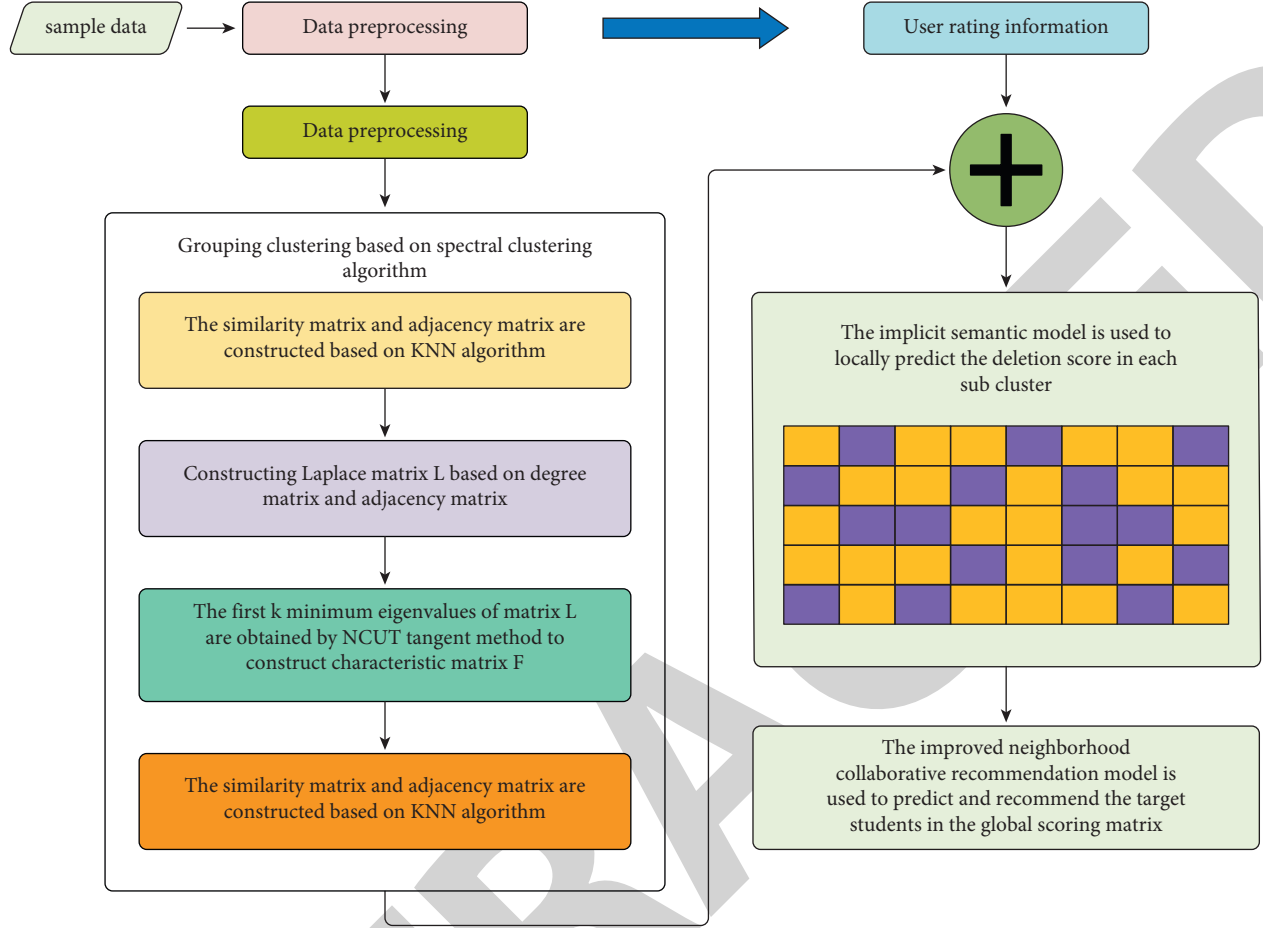


FIGURE 1: The framework model of the proposed algorithm.

be used to learn. In addition, in order to prevent overfitting, the overfitting term can be added to the loss function $\lambda(\|u_p\|^2 + \|v_x\|^2)$, λ is the regularization parameter.

In addition, in practice, some attributes of students have nothing to do with college English online courses and some attributes of college English online courses have nothing to do with students. Therefore, bias items can be added to the prediction model, and SVD models with bias items added are called BiasSVD models.

3.4. Cluster Students Based on Student Characteristics and Spectral Clustering Algorithm

- (1) The sample point $I = \{i_1, i_2, \dots, i_t\}$ and then the student similarity matrix $S = \{s_{xy}\}_{t \times n}$ are calculated by using the K-nearest neighbor algorithm based on Gaussian kernel function and the student tag feature vector. Here, n is the label feature dimension.

$$s_{xy} = \exp\left(-\frac{\|i_x - i_y\|_2^2}{2\sigma^2}\right). \quad (4)$$

Then, the adjacency matrix $M = \{m_{xy}\}_{t \times n}$ is constructed. The similarity matrix constructed by the K-nearest neighbor method is not symmetric.

Therefore, a symmetric K-nearest neighbor similarity matrix is constructed in the following way. As long as a point is in another point's k-nearest neighbor, S_{xy} is retained.

$$m_{xy} = \begin{cases} 0, & i_x \notin ZTT(i_y) \& i_y \notin ZTT(i_x), \\ \exp\left(-\frac{\|i_x - i_y\|_2^2}{2\sigma^2}\right), & i_x \in ZTT(i_y) | i_y \in ZTT(i_x). \end{cases} \quad (5)$$

- (2) We construct degree matrix D_{wt} according to the connection matrix; degree matrix D is a diagonal matrix.
- (3) We calculate the Laplace matrix L : $L = d - m$.
- (4) We use Ncut to find k minimum eigenvalues of Laplace matrix L to construct the characteristic matrix F .

First, the normalized Laplace matrix L_s is constructed, $L_s = D^{-1/2} L D^{-1/2} = I - D^{-1/2} W D^{-1/2}$, where x is the identity matrix.

We calculate the eigenvalues of normalized Laplacian matrix L_s , select the first k minimum eigenvalues, and calculate the corresponding eigenvectors f_1, f_2, \dots, f_k .

The matrix composed of the above k feature vectors as column vectors is normalized according to rows, and finally, the feature matrix $N = \{f_1, f_2, \dots, f_k\}$ and $N \in R^{t \times k}$ with dimension $t \times k$ are formed.

- (5) Let $b_x \in R^k$ be the i -th row vector of the characteristic matrix n as the new intermediate data sample point, where $x = 1, 2, \dots, t$, and then, we use the k -means clustering to cluster the new sample points $B = \{b_1, b_2, \dots, b_t\}$ into clusters $\{G_1, G_2, \dots, G_k\}$.
- (6) The cluster of the new sample points is transformed into the original student cluster $C = \{C_1, C_2, \dots, C_k\}$, where $C_x = \{y | b_y \in G_x\}$.

3.5. Missing Score of Local Prediction Based on the Cryptic Model. After grouping and clustering students based on the above steps, the original scoring matrix with a higher dimension can be divided into k smaller subscoring matrices. The cryptic meaning model based on matrix decomposition will be used to fill the missing score in the scoring matrix to solve data sparsity. The operations for each subscoring matrix are as follows.

Suppose $R_{a \times w}$ is a subscoring matrix, a is the number of students in the corresponding subcluster, and w is the number of college English online courses in the sample. In this paper, BiasSVD algorithm is used to decompose and predict the scoring matrix. The BiasSVD algorithm assumes that the scoring system includes two parts, bias term and interaction factor between students and college English online courses, as shown in

$$\hat{r}_{px} = \mu + h_p + h_x + \sum_f u_{pf} \cdot v_{xf}. \quad (6)$$

Among them, the bias items include global mean μ , student bias item h_p , and college English online course bias item h_x .

In the cryptic model, the parameters h_p , h_x , u_{pf} , and v_{xf} in Formula (6) are obtained by minimizing the loss function in

$$L = \sum_{(p,x) \in \text{train}} \left(r_{px} - \mu - h_p - h_x - \sum_f u_{pf} \cdot v_{xf} \right)^2 + \lambda \left(\|u_p\|^2 + \|v_x\|^2 + \|h_p\|^2 + \|h_x\|^2 \right). \quad (7)$$

Here, $\lambda (\|u_p\|^2 + \|v_x\|^2 + \|h_p\|^2 + \|h_x\|^2)$ is a regular term added to prevent overfitting.

Then, the stochastic gradient descent (SGD) method is used to solve the above loss function, and the partial derivative of each parameter can be obtained as follows:

$$\begin{aligned} \frac{\partial L}{\partial u_{pf}} &= -2\rho_{px} \cdot v_{xf} + 2\lambda u_{pf}, \\ \frac{\partial L}{\partial v_{xf}} &= -2\rho_{px} \cdot u_{pf} + 2\lambda v_{xf}, \\ \frac{\partial L}{\partial h_p} &= -2\rho_{px} + 2\lambda h_p, \\ \frac{\partial L}{\partial h_x} &= -2\rho_{px} + 2\lambda h_x, \end{aligned} \quad (8)$$

where $\rho_{px} = r_{px} - r_{px} = r_{px} - \mu - h_p - h_x - \sum_f u_{pf} \cdot v_{xf}$. Therefore, parameters h_p , h_x , u_{pf} , and v_{xf} can be obtained iteratively by the following recursive formula:

$$\begin{aligned} h_p &\leftarrow h_p + \gamma(\rho_{px} - \lambda h_p), \\ h_x &\leftarrow h_x + \gamma(\rho_{px} - \lambda h_x), \\ u_{pf} &\leftarrow u_{pf} + \gamma(v_{xf} \cdot \rho_{px} - \lambda u_{pf}), \\ v_{xf} &\leftarrow v_{xf} + \gamma(u_{pf} \cdot \rho_{px} - \lambda v_{xf}). \end{aligned} \quad (9)$$

Here, γ is the learning rate. Through the above implicit semantic model based on BiasSVD algorithm, the missing score can be locally predicted in each subscoring moment.

3.6. Score Prediction. After the local initial prediction of missing score in each subcluster, the subscore matrix was combined into the original score matrix and the improved neighborhood-based collaborative recommendation model was used to make the quadratic global prediction. The scoring matrix becomes very dense after missing scoring through local filling. If the traditional neighborhood-based collaborative recommendation model is used, the similarity value between all pairs of students needs to be calculated, which requires a large amount of calculation. Therefore, this paper uses k -means clustering algorithm again to cluster students based on student scoring vector and divides the student set into k classes again. Then, in the cluster where the target student is located, the similarity between the target student p and other students in the subcluster is calculated based on the Pearson Correlation Coefficient (PCC). The calculation equation is as follows:

$$s_{xw}(p, q) = \frac{\sum_{x \in X_{pq}} (r_{px} - r_p) \cdot (r_{qx} - r_q)}{\sqrt{\sum_{x \in X_{pq}} (r_{px} - r_p)^2} \sqrt{\sum_{x \in X_{pq}} (r_{qx} - r_q)^2}}, \quad (10)$$

where r_{px} and r_{qx} represent the scores of student p and student q for college English online course x , respectively. X_{pq} represents a collection of online college English courses that are all graded p and q by students. r_p and r_q represent the mean of student p and student q scores, respectively.

Here, to set a threshold value of δ , $Tex(p) = \{q | stxm_wq(p, q)h \geq \delta x, 7qC \in ; P\}$. P is the whole set of students, so the score of target student p on college English online course x can be predicted by

$$ur_{px} = r_l + \frac{\sum_{q \in Tex(p)} (r_{qx} - r_l) \cdot sxw(p, q)}{\sum_{q \in Tex(p)} |sxw(p, q)|}. \quad (11)$$

4. Result Analysis and Discussion

The experimental data set is from the actual operation data of an online teaching website, with 13,680 students and a total of 737 courses, mainly college English-related courses. The data included students' learning records and scoring records from May 2014 to July 2017, with a total of 148,170 records. The training set accounted for 80%, about 118,000 records, and the test set accounted for 20%, about 30,000 records. First, the data are simplified into triples (student id, study time, and course id).

The evaluation index of the algorithm is precision, which refers to the proportion of the courses actually learned by students among all the courses recommended for display, as shown in

$$\text{precision} = \frac{\sum_{p \subseteq P} R(p) \cap N(p)}{\sum_{p \subseteq P} R(p)}, \quad (12)$$

where $N(p)$ represents all courses actually learned by student p and $R(p)$ represents all courses recommended to student p . The higher the accuracy rate is, the better the recommended courses meet students' expectations.

We input the course sequence that students have learned in the test set, output a course sequence after model processing, take the last course as the recommended course of students, and judge whether the recommended result is accurate compared with the courses that students actually learn.

All courses are divided into three categories: English reading, English listening and speaking, and English writing. The data set is divided into three subsets accordingly. Table 1 records the recommendation results based on the traditional collaborative algorithm under the manual classification of websites.

The recommendation results of all categories are generally better than those of all courses after classification.

The algorithm in this paper is used for automatic classification of courses, and three course categories are obtained. Table 2 shows the corresponding recommendations.

Compared with the results of manual classification in Table 1, the recommendation algorithm performs better than manual classification in most categories divided and the accuracy of weighting is increased by 8.2%.

The comparison of the accuracy of the proposed algorithm with those in literature [11, 18–20] and literature [21] in the same data set is shown in Table 3 and Figure 2.

Except for all course categories, the accuracy index of the proposed algorithm is much higher than of the other five

TABLE 1: Recommended results based on artificial classification of websites.

Category	Number of courses	Accuracy
All courses	137	0.126
English reading	38	0.298
English listening and speaking	47	0.373
English writing	52	0.387
Weighted accuracy	—	0.206

TABLE 2: Recommended results based on the proposed algorithm.

Category	Number of courses	Accuracy
All courses	137	0.126
Course 1	29	0.211
Course 2	45	0.369
Course 3	63	0.406
Weighted accuracy	—	0.288

algorithms. Compared with the other five algorithms, the proposed algorithm is more suitable for the recommendation of courses with strong temporal dependence.

The performance of the intelligent collaborative recommendation method based on the spectral clustering and cryptic model is not only related to the structure size of the collaborative recommendation algorithm but also highly dependent on the training sample size. Therefore, the sample size of training participants was set differently to verify its recommended performance, and the results are shown in Table 4 and Figure 3. The initial training and testing sample ratio is 8:2.

When the number of training samples decreases, the recommended RMSE values of the three data sets all rise. When the proportion of the training set decreased from 80% to 20%, the RMSE performance of English reading, English listening and speaking, and English writing decreased by 34.11%, 36.77%, and 42.93%, respectively. By comparison, the personalized recommendation of English writing is most sensitive to the sparsity of the training sample set, followed by the sparsity of English listening and speaking, and the sparsity of the sample set has the least influence on the sparsity of English reading. In conclusion, when the proportion of the training set is 80%, the optimal personalized recommendation performance can be obtained.

To verify the recommended performance of different algorithms for three kinds of data sets, six algorithms were used to train the three kinds of data sets, respectively. Figures 4–6 show the results. According to the results in Table 4, the number of nodes involved in training for the six algorithms is 80% of the total sample number.

RMSE in this paper includes all the lowest values, which indicates that the proposed algorithm has the highest recommendation accuracy for these three data sets. In terms of order of accuracy of personalized recommendation, the algorithm in this paper has the best performance, followed by literature [20], and those in literature [18] and literature [21] have the worst RMSE performance. In terms of running time, algorithms in literature [18] and literature [21] are the best, while the algorithm in this paper and literature [20]

TABLE 3: Accuracy comparison of six algorithms.

Category	Literature [18]	Literature [19]	Literature [20]	Literature [11]	Literature [21]	Proposed
All courses	0.031	0.016	0.045	0.022	0.077	0.126
Course 1	0.016	0.021	0.015	0.012	0.019	0.038
Course 2	0.055	0.028	0.062	0.069	0.079	0.098
Course 3	0.112	0.141	0.122	0.137	0.155	0.186

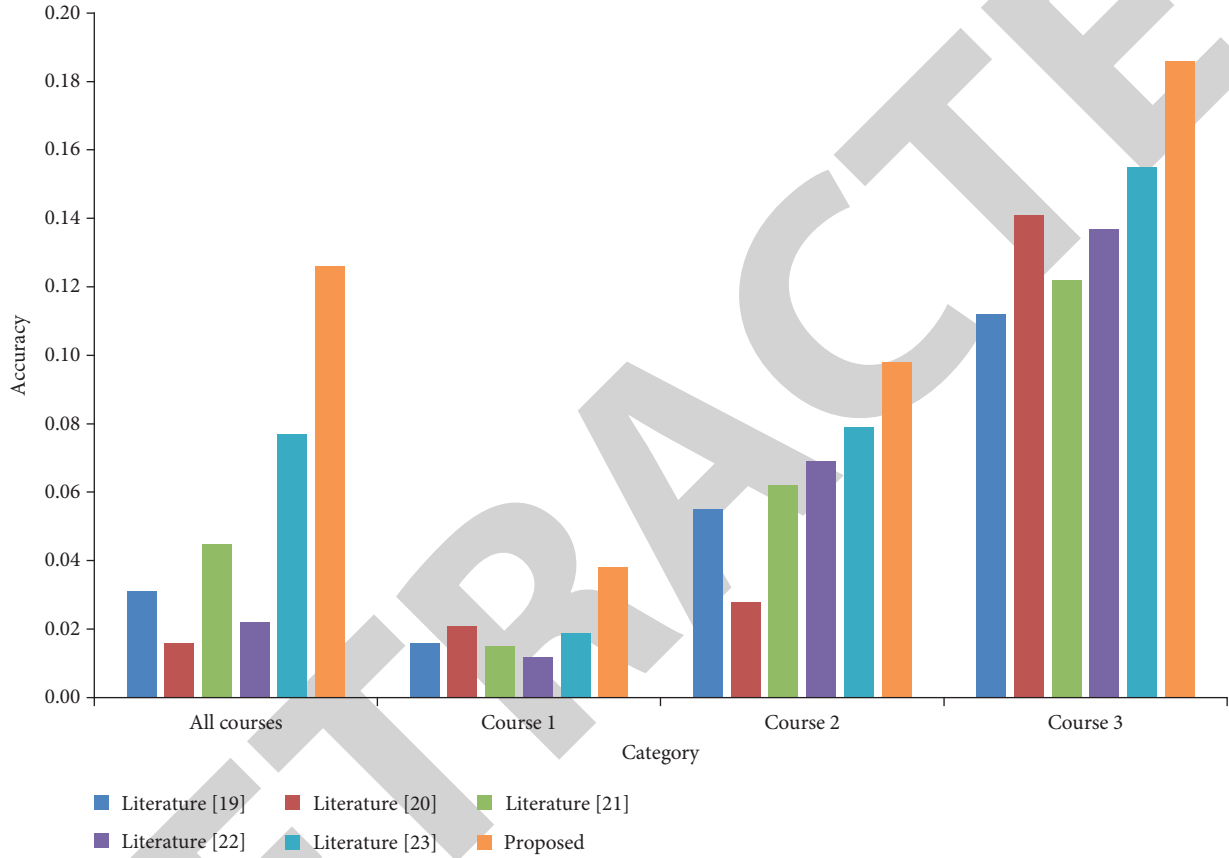


FIGURE 2: Accuracy comparison of six algorithms.

TABLE 4: RMSE of different training sample sizes.

→Data set	Training set ratio/%	RMSE
English reading	80	0.8248
	60	0.8969
	40	0.9255
	20	1.1659
English listening and speaking	80	0.839
	60	0.9194
	40	0.9391
	20	1.2067
English writing	80	0.9685
	60	1.0011
	40	1.1506
	20	1.3978

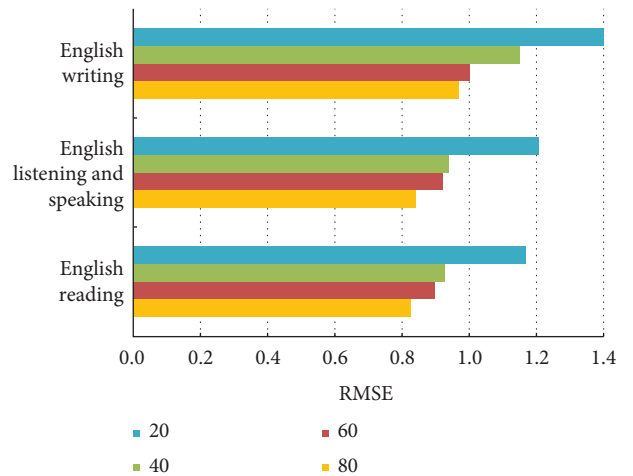


FIGURE 3: RMSE with different training sample sizes.

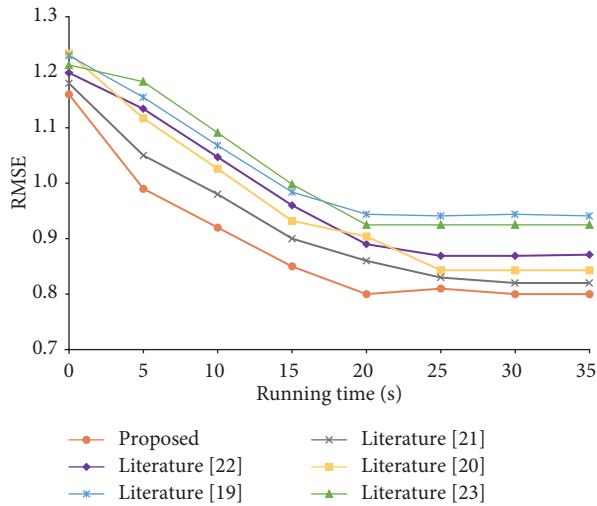


FIGURE 4: RMSE of six algorithms (English reading).

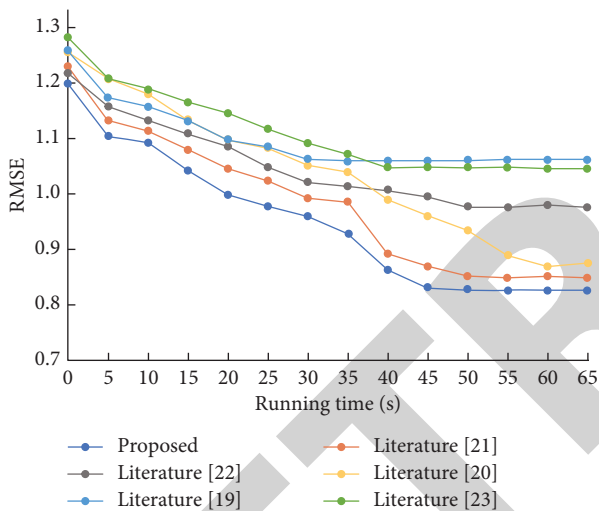


FIGURE 5: RMSE of six algorithms (English listening and speaking).

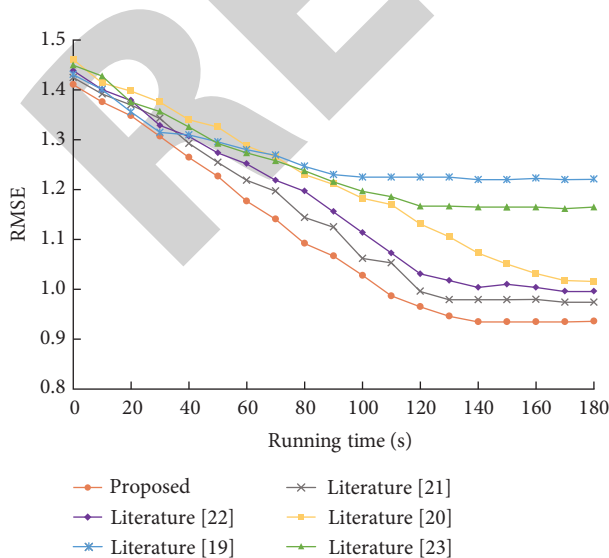


FIGURE 6: RMSE of six algorithms (English writing).

perform poorly. The main reason is that the operation of the deep learning framework requires multiple positive and negative updates, resulting in high operation time consuming steps.

5. Conclusion

No recommendation algorithm is absolutely superior to another recommendation algorithm. Therefore, multiple recommendation models can be effectively integrated to build a hybrid recommendation model with higher performance. Based on this, an intelligent collaborative recommendation method based on spectral clustering and cryptic model is proposed. The method uses the KNN model-based spectral clustering algorithm to mine similar information among students and then groups the students into clusters. Then, the original scoring matrix is divided into several subscoring matrices with lower dimensions based on clustering. Then, a matrix decomposition model based on the cryptic meaning model is used to locally predict the missing score in each subscore matrix. Finally, the improved neighborhood-based collaborative recommendation algorithm is used to predict the global score of the target students. Experimental results show that the proposed algorithm effectively solves the problem of data sparsity and cold start and accelerates the efficiency of the recommendation algorithm while improving the accuracy of prediction. The next step mainly includes constructing the relationship diagram between students and English online courses by using a knowledge graph to obtain more specific characteristics of students and English online courses and constructing a prediction model by using the deep learning method to further improve recommendation accuracy.

Data Availability

The labeled data set used to support the findings of this study is available from the author upon request.

Conflicts of Interest

The author declares no conflicts of interest.

Acknowledgments

This study was sponsored by English Department, Taiyuan University.

References

- [1] M. Shi and T. Hu, "Discussion on the resources construction and service of university library in the era of Internet plus," *Curriculum and Teaching Methodology*, vol. 4, no. 3, pp. 63–68, 2021.
- [2] D. Grewal, S. Motyka, and M. Levy, "The evolution and future of retailing and retailing education," *Journal of Marketing Education*, vol. 40, no. 1, pp. 85–93, 2018.
- [3] Y. Zhonggen, Z. Ying, Y. Zhichun, and C. Wentao, "Student satisfaction, learning outcomes, and cognitive loads with a mobile learning platform," *Computer Assisted Language Learning*, vol. 32, no. 4, pp. 323–341, 2019.

Retraction

Retracted: A Grey Prediction Algorithm for Enterprise Human Resource Management Validity Model Construction and Improvement

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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] Y. Yang, "A Grey Prediction Algorithm for Enterprise Human Resource Management Validity Model Construction and Improvement," *Security and Communication Networks*, vol. 2022, Article ID 2023610, 11 pages, 2022.

Research Article

A Grey Prediction Algorithm for Enterprise Human Resource Management Validity Model Construction and Improvement

Yajing Yang 

Hebei Chemical & Pharmaceutical College, Shijiazhuang 050026, China

Correspondence should be addressed to Yajing Yang; yangyajing7@126.com

Received 9 May 2022; Revised 29 May 2022; Accepted 20 June 2022; Published 8 July 2022

Academic Editor: Tao Cui

Copyright © 2022 Yajing Yang. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

With the deepening development of economic globalization and world economic integration, all enterprises are faced with an increasingly complex and competitive living environment. Therefore, it is particularly important to formulate a human resource strategy suitable for the enterprise's own development to cope with the external challenges and external competition of the enterprise. However, in the current management practice of state-owned enterprises including power supply enterprises in our country, it is rare to make strategic decisions on human resources by applying scientific, effective, and complete mathematical models. Taking construction enterprises as an example, this study combines human resource management, enterprise management, project management, comprehensive evaluation, and grey system and other theories to systematically study the effect of human resource management in enterprises, and finally constructs a suitable evaluation method for construction enterprises, and an assessment model for diagnosing its human resource management status. We provide practical guidance for the management of human resources in construction enterprises, which is conducive to human resource workers to discover existing problems in time and make improvements, give full play to the potential of human resources, and improve the level of human resource management and the value of enterprises.

1. Introduction

With the continuous development of economic globalization and high-speed integration of information, China's enterprises are facing an increasingly complex, changing, and increasingly competitive living environment. If enterprises want to have a more relaxed and comfortable living space, and more long-term and broad development prospects, they must explore a more scientific, efficient, and rigorous system of sustainable development. In this development process, human resources play a particularly important role; human resources are not only the main resource of all resources but also the backbone of all positions in the enterprise; and the staffing of any position requires the solid support and coordination of human resources. The core of enterprise competition is the competition of human resources; human resources in turn affect the implementation of enterprise strategy; and there is an irreplaceable mutual force between enterprises and human

resources [1]. Therefore, enterprises should attach great importance to human resources, increase the research, strength, and depth of human resource strategy, and make reasonable use of decision-making methods to make decisions on human resource strategy programs. At the same time, it is necessary to develop a human resource strategy in conjunction with the enterprise's own situation and optimize resource allocation so as to establish core competitiveness in the current complex market environment of both opportunities and challenges [2].

“Value evaluation” emphasizes the establishment of a scientific value evaluation and assessment system, which includes personality evaluation, professional behavior ability evaluation, and key performance index evaluation. First, personality evaluation refers to the evaluation of whether employees have the personality characteristics required by a position, or “theme characteristics.” To evaluate personality traits, we must first establish the quality model of various positions in the enterprise. For example, development

positions, pilot test positions, and sales positions all require different quality requirements of employees, forming the quality model of different positions. On this basis, the corresponding evaluation system can be established to determine whether the relevant employees have the personality characteristics required by a certain position; second, the evaluation of professional behavior ability refers to the evaluation of whether employees have the job behavior ability required by a job or job competence.

Human resource strategy plays an important supporting role in the expansion and long-term development of enterprises. With the development of economy, human resource strategy, as the first resource strategy in the economic knowledge era, has been highly valued by scholars and enterprise managers at home and abroad. The complex and changeable environment makes people gradually realize that the competition of all social and economic activities is fundamentally the competition of human resources. Human resource strategy is a set of binding and guiding management strategies on the selection, employment, and layoff of human resources, which involves goals, plans, and guidelines from the premise of external environment such as market environment, economic environment, political environment, and social environment in which the enterprise is located at home and abroad, and from the starting point of long-term development and overall interests of the enterprise [3]. Especially after China's accession to the WTO, the competition for human resources in various industries has become more and more intense. Only with strong competitive human resources can enterprises achieve their ultimate strategic goals, promote the growth of efficiency, and finally maximize their profits. Modern human resources pay more attention to the strategic position of human resources in the enterprise, while human resource development and human resource quality are regarded as a holistic concept. Thus, it seems that making good strategic HR decisions is crucial for the company [4].

The classical decision-making methods such as principal component analysis and ideal solution method have achieved relatively satisfactory results in deterministic decision-making work. However, in real life and social practice, people are often faced with an uncertain decision problem where some information is known and some information is unknown, and currently, the application of grey system theory to decision-making becomes the main trend [5]. Different decision methods have different scopes and fields of application; therefore, the comparative advantages and limitations of evaluation methods should be comprehensively and objectively analyzed; suitable evaluation methods should be explored according to specific fields and actual situations; and then, comprehensive decision models should be established.

The purpose of this study is to embed rich scientific theoretical research and innovative thinking and concepts into the practical application of human resources in Chinese enterprises so that enterprises can better make effective decisions in human resource strategy, and a suitable decision-making method can be reached. The human resource strategic decision-making method with practical operation

makes human resource human-oriented in management methods, transparent in salary management, and modern in management methods. The main frame schematic is shown below. By constructing a scientific and reasonable quantitative system, the difficult-to-solve human resource strategic decision-making problems can be effectively solved through objective and scientific qualitative and quantitative analysis, and the theoretical content of human resource disciplines can be enriched, scientific, and formalized [6]. At the same time, it can provide a new method and new tool for human resource decision-making, so that enterprises can better and more fully take human resources as an important starting point, mobilize the initiative and creativity of human resources, and then improve the labor productivity of enterprises. Long-term strategic goals and long-term development are shown in Figure 1.

2. State of the Art

Over the past hundred years, modern organizational management has shown a historical trend of "human nature gradually emerging," which can be roughly divided into several stages: the era of labor management based on the classical management (especially Taylor's scientific management) theory at the end of the 19th century and the beginning of the 20th century; in the middle of the 20th century, the era of personnel management based on the theory of organizational behavior and interpersonal relationship; and at the end of the 20th century and the beginning of the 21st century, the era of human resource management based on the human capital and strategic management theory.

In recent years, under the background of digital technology network, globalization of market economy and humanization of social development, "people-oriented and strategic incentive," have become the common direction and inevitable choice of all kinds of economic and social organizations in the world to obtain and maintain strategic competitive advantage and realize long-term sustainable development.

After years of development, the human resource service industry has become a supporting industry in the service industry, and its development scale is large; Majchrzak et al. concluded from statistics that in the United States, outsourcing services account for more than one-half of the service industry; in addition, personnel outsourcing services account for the largest proportion of outsourcing services; and according to statistics, personnel services account for 10% of outsourcing services [7]. According to Mathematics - Grey System Theory, the growth trend of HR service outsourcing in the U.S. is obvious in recent years, with an average annual growth rate of about 9%, and through the analysis of the growth trend in recent years, they predict that the future demand for HR services is still on the rise [8]. The rapid development of the HR service industry has driven a large increase in social employment. Mathematics - Grey System Theory [9] showed that there is a positive relationship between the growth of the HR service industry and social employment rate. All the above scholars conclude that

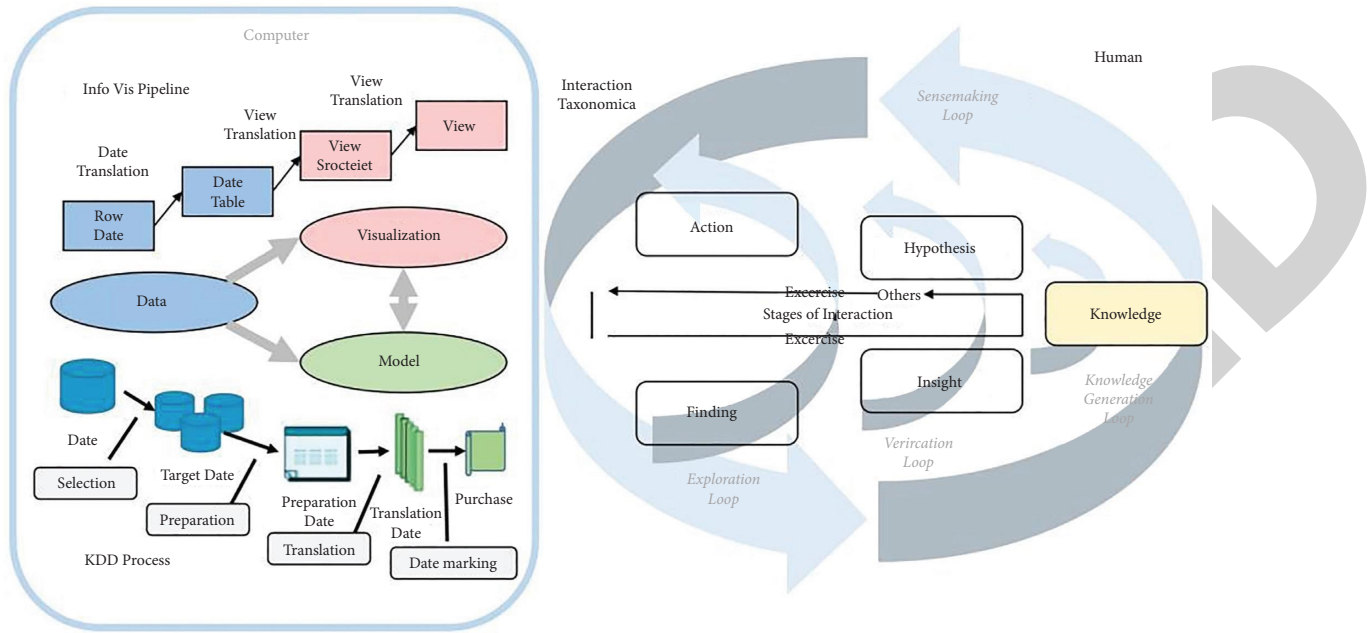


FIGURE 1: Human resource evaluation block diagram.

the HR service industry has a positive effect on social employment, and with this, some scholars have conducted targeted research on the development of the HR service industry itself. Wang et al. shows that the HR service industry has a positive effect on social employment [10]. Javanmardi et al. noted that firms should use HR service outsourcing for noncore activities, such as laundry services in the hospitality industry, and the operations such as security and environmental maintenance [11].

Most studies suggest that HR service outsourcing can save costs and improve the core competitiveness of firms, and Mathematics - Grey System Theory studied which sector is more efficient when job placement services are provided by the public and private sectors, and the results showed that the private sector is more efficient than the public sector [12].

Unlike our country, there is currently no clear and uniform definition of HR services in foreign countries. Many countries follow the systematic industrial classification dictionary to classify various industries in the national economy, but neither the North American Industrial Classification System (NAICS) nor the International Standard Industrial Classification (ISIC) clearly classifies the human resource service industry as an independent category [13]. By searching the relevant data and literature, the classification methods of North American countries, the United Kingdom, Japan, and Singapore, where the human resource service industry is more developed, were sorted out. (1) North American countries. In the North American Industrial Classification System (NAICS) jointly implemented by the U.S., Canada, and Mexico, human resource service-related businesses are found in the following areas: (1) administrative and general management consulting services and human resource and senior management search consulting services; (2) employment services, including

employment placement agencies, temporary support services, and employment services. (2) The UK differs from North America; in that, it classifies human resource services under the category of “business management and management consulting” in the “other business services” category [14]. This category can be divided into three smaller sorts: (1) Human resource management consulting; (2) labor recruitment and personnel services; (3) management training services. In the “other business services” category, there are “private employment agencies” and “unclassified services” related to human resource services. Among them, “unclassified services” includes two categories: “labor dispatch” and “unclassified services.” According to the Singapore Standard Industrial Classification (SSIC), industries related to human resource services are mainly distributed in the following categories: (1) “human resource consulting services”; (2) employment services; and (3) professional and management development training.

3. Methodology

3.1. Overview of Human Resources. Corporate culture is the “character” of an enterprise and is the sum of the values, business ideas, group consciousness, and code of conduct formed by the enterprise in the process of long-term production and operation. A good corporate culture will have the following impact on the development of human resources: through the moisture of corporate culture, employees’ work enthusiasm is stimulated and employees’ enthusiasm is mobilized. Through the subtle influence of corporate culture, the behavior of each employee is standardized, employees’ dedication to society is stimulated, and a good corporate culture is instilled into employees, so that employees feel that they are working not only for the

enterprise but also for the progress of society, so as to produce a sense of participation, self-realization, and nobility, and mobilize their work and enthusiasm. Therefore, it is necessary to study the application of corporate culture in human resource management.

Although the study of human resource management in China started later than that in western countries, in enterprise practice, with the gradual deepening of international economic integration and the continuous and rapid development of the domestic market economy, enterprises are paying more and more attention to human resource management, improving to the height of strategy, and forming human resource strategy [15]. According to the current research results, China has not formed a unified and publicly recognized concept of human resource strategy, but it can be seen from the suggestions on the implementation of human resource strategy that the academic circle has a similar understanding of the essence of human resource strategy.

Evaluation model. According to the system theory and the HRM theory, enterprise HRM can be regarded as a system. The HRM system practice includes human resource planning, position analysis and career planning, human resource recruitment and selection, human resource training and development, salary management, performance evaluation, promotion management, employee management, employee welfare plan, and other functions.

In addition, a human resource strategy can promote the improvement of enterprise benefits. By making full use of human resources and integration, not only can we effectively save the enterprise equipment use, prolong the service life of infrastructure, and save to buy more of the labor force capital expenditures and reduce human resource cost, but also will improve the labor productivity of employees, so as to greatly improve the operational efficiency of enterprises and bring more profits to the enterprise.

3.2. Grey System Theory

3.2.1. The Connotation of Grey System Theory. The grey system theory was founded in 1982 by Professor Voskoglou, a Chinese scholar [16]. It is a new method to study and deal with uncertain systems with a small amount of data and insufficient information based on mathematical theory. Its main working principle is to use mathematical methods to excavate and develop the known part of the information, study the logical relationship between mathematics and physics, through the research of data "behavior" and rules, can correctly express the system operation rules, and has achieved the purpose of developing and using the system. In the real world, there are generally "small sample" and "poor information" uncertain systems. The grey system theory provides theoretical guidance for describing and understanding these systems.

3.2.2. Application of Grey System Theory. The grey system theory is good at dealing with "poor information" of statistical method, usually less data in the system, not through statistical methods' system behaviors under the condition of

application, is a complement to the method of statistics, so in the social, economic, and engineering technology in areas such as prediction and evaluation, and is widely used in decision-making problems. For example, Liu and Ye applied grey correlation theory to investment decision problems and constructed a decision system model based on the grey correlation method [17]. Yan Jun et al. developed a general quantitative measurement system, which is widely applicable in a social and economic system based on the grey correlation method. In the distributed interactive simulation, Zheng et al. [18] made a comprehensive evaluation of the combat scheme according to the simulation results by using the grey correlation analysis method. The evaluation results showed that the evaluation results obtained by using this method were objective and true, and were in line with the actual situation of enterprises. Chen et al. used the grey system theory to construct the evaluation index system for the implementation effect of an emergency plan and verified it [19]. The results showed that the grey system theory was more scientific and reasonable to construct the index system. All these studies have achieved good results, which verify the validity of the grey theory applied to the uncertain system with small samples. The research sample of this study is too small to be studied by statistical method, so grey system theory is adopted for empirical research.

4. Result Analysis and Discussion

4.1. Determine the Weight of Human Resource Management Effect Evaluation Index. The coordination of human resource management system runs through the inside and outside of human resource management system, which is the overall requirement of system function. The benefit of human resource management is the comprehensive embodiment of system coordination, system efficiency, and effect. Therefore, we should evaluate the benefits of enterprise human resource management from three dimensions: coordination, efficiency, and effect, that is, its adaptability, execution, and effectiveness. The basic framework of enterprise human resource management evaluation index system should also be taken into account.

Adaptability is the reflection of internal and external coordination of human resource management system. External coordination mainly includes the adaptability of human resource management policies to the labor market, the compliance with laws, the compatibility with enterprise development strategy, business philosophy, and enterprise culture, and the coordination and cooperation of human resource management system and other subsystems of the enterprise. Internal coordination mainly refers to the coordination between various functions of human resource management, and the coordination and cooperation between human resource management professionals and front-line managers. Executive reflects the internal operation of enterprise human resource management system.

Analytic hierarchy process (AHP) is a weight determination method combining qualitative analysis and quantitative analysis proposed by Zhang, a professor at the University of Pittsburgh in the United States, in the 1970s.

The analytic hierarchy process (AHP) first divides the complex problems to form a multilayer analysis structure model and then calculates the weight of each index by the combination of mathematical method and qualitative analysis [20]. It is a simple, flexible, and practical multicriteria decision-making method, which is widely used in the field of performance evaluation. The specific steps to determine the weight of human resource management effect evaluation index of construction enterprises by AHP are as follows.

4.1.1. Establish Hierarchical Structure According to Evaluation Objectives. According to the evaluation of target-human resource management performance evaluation of construction enterprises, various index elements to achieve the goal are constructed into a hierarchical multilayer structure index system according to the relationship between each other. This study has constructed a four-level performance evaluation system of human resource management in construction enterprises, in which the highest level is the target layer, that is, the goal to be achieved by evaluation. The middle layer is the criterion and sub-criterion layer, which is the judgment criterion to measure whether the goal can be achieved. The last layer is the scheme layer, that is, all possible schemes and measures to achieve the goal.

4.1.2. Construct the Judgment Matrix. The judgment matrix is the quantitative basis of tomographic analysis, and the basis of relative importance calculation and single-hierarchy sorting. The weight of each index can be obtained through a series of operations on the judgment matrix. It is formed by pairwise comparison and judgment of the relative importance of indicators at the same level by experts in related fields, taking an index A above the level as the evaluation criterion. The construction process of the judgment matrix is as follows:

- ① To design a questionnaire, this study invites human resource management researchers and experienced human resource management personnel of construction enterprises to evaluate the importance of human resource management evaluation indicators of construction enterprises. The selection of experts should not be too little or too much. Too little cannot effectively reduce the error caused by individual differences, but too many experts will make the actual operation difficult, and the data processing process is too complicated.

In order to quantify the comparative results of relative importance and form a numerical judgment matrix, the 1–9 scale method proposed by Professor T.L. Saaty was adopted to quantify the judgment (psychologists believe that there should not be more than 9 factors for paired comparison, that is, there should not be more than 9 indicators in the same group), as shown in Table 1. According to the meaning of these scales,

experts can compare elements of each level in pairs to form a judgment matrix.

- ② The questionnaire is organized, and the judgment matrix is constructed.

By sorting out the questionnaire, the arithmetical average value of the scoring results of each expert was calculated, which is the relative importance of the corresponding index. According to the expert scoring results, the judgment matrix A-B is obtained as shown in Table 2.

4.1.3. Hierarchical Single Sorting and Consistency Test

(1) *Hierarchical Single Sorting.* The hierarchical single ranking is to calculate the importance weights of the indexes related to this layer and adjacent upper layers through the judgment matrix. In essence, it is to solve the eigenvector W corresponding to the maximum eigenvalue of judgment matrix B , and the W obtained is the weight of the index in single hierarchical order. Combining the principle of the root method (see equations (1)~(3)) with the calculation function of EXCEL, the eigenvalues and W can be quickly calculated. Tables 2 to 13 show the judgment matrix and calculation results of a single ranking of indicators at each level.

$$\bar{W}_i = n \sqrt[n]{\prod_{j=1}^n B_{ij}} \quad (i, j = 1, 2, \dots, n), \quad (1)$$

$$W_i = \frac{\bar{W}_i}{\sum_{i=1}^n \bar{W}_i}, \quad (2)$$

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^n \frac{(BW)_i}{W_i}. \quad (3)$$

(2) *Consistency Test of Judgment Matrix.* To satisfy the transitivity axiom simply means that the experts have basically the same scale requirements for the pairwise comparison of indicators when constructing the judgment matrix. However, the complexity of objective things and the diversity of evaluation indicators often result in one-sided and diversified cognition of decision-makers, that is, the judgment matrix obtained by nine scales may also have inconsistent judgment, so a consistency test must be carried out. The consistency test is a very important and indispensable step in analytic hierarchy process, which is directly related to the reasonable weight calculation. The specific inspection process is as follows:

We calculate consistency index CI as follows:

$$CI = \frac{\lambda_{\max} - n}{n - 1}. \quad (4)$$

The random consistency ratio CR was calculated, and the consistency was judged.

TABLE 1: Importance of a matrix description of scales 1 to 9.

The value of P_{ij}
9
7
5
3
1
2, 4, 6, 8
Reciprocal

TABLE 2: Judgment matrices A-B.

A	B1	B2
B1	1	1/2
B2	2	1

$$CR = \frac{CI}{RI} \quad (5)$$

RI is the average random consistency index of the judgment matrix. RI values of order 1–9 judgment matrix are shown in Table 3.

The discriminant criteria are as follows: $n < 2$, the judgment is completely consistent; $N > 2$; when $CR < 0.1$, the judgment inconsistency can be accepted; when $CR > 0.1$, the judgment inconsistency cannot be accepted, and the matrix needs to be modified.

According to the above calculation method of single ranking of levels and consistency test, the relative index weights of each level of the human resource management effect evaluation system of construction enterprises are obtained as shown in Tables 4 to 13, which all meet the consistency requirements.

4.1.4. Hierarchical Total Ordering and Consistency Test.

The hierarchical total ranking is for the total goal, and the highest ranking of each factor is its hierarchical total ranking. On the basis of hierarchical single ranking, the importance of each factor to the target layer is calculated from top to bottom, and the absolute weight is obtained.

Suppose one of the layers (layer A) contains A_1, A_2, \dots, A_m , A_m contains m elements, and the hierarchical total ranking weights of each index are, respectively, a_1, a_2, \dots, a_m ; let the next layer (layer B) contain B_1, B_2, \dots, B_n , there are n elements in B_m , and the single-order weights of elements in B layer about A_j are $b_{1j}, b_{2j}, \dots, b_{nj}$. Then, the total ranking weights of each factor in layer B are, respectively, b_1, b_2, \dots, b_n , i.e.,

$$b_j = \sum_{i=1}^m b_{ij} \cdot a_i \quad (i = 1, 2, \dots, n). \quad (6)$$

Although the consistency test has been carried out for the single sort of each level, the total sort will add up the

TABLE 3: RI values of order 1–9 judgment matrix.

n	1	2	3	4	5	6	7	8	9
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

inconsistencies of each level from top to bottom, which will still result in the inconsistency of the calculation result. Therefore, the consistency test is also required for the total sort of each level, and the calculation formula is as follows:

$$CR = \frac{\sum B_i CI_i}{\sum B_i RI_i} \quad (7)$$

where B_i is the weight of each subsystem; the discriminant criterion is the same as that of the consistency test. The CR of hierarchical total ranking is not more than 0.10, so the judgment matrix meets the consistency requirement.

The advantages and disadvantages of analytic hierarchy process are as follows:

(1) Advantages

- (1) Systematic analysis method;
- (2) Simple and practical decision-making methods;
- (3) Less quantitative data information is required.

(2) Shortcomings

Unable to provide new solutions for decision-making.

4.2. Grey Clustering Evaluation Theory. The research object of grey system theory is “small sample” system with partially known information and relatively little data information. The description and monitoring of system behavior mainly depend on the known part of information. At an international economic conference in the early 1980s, Professor Deng Julong, a Chinese scholar, first puts forward this theory as a participant, marking the formal establishment of this theory.

The basis of grey whitening weight function clustering is the whitening weight function of grey number. The whitening weight function is a functional expression of the possibility of taking the value of each element in grey number (grey class). Each point in the function image describes the probability of taking a specific value within the range of grey number. The whitening weight function of j index k subclass is denoted as $f_j^k(\cdot)$. In practical application, the following four whitening weight functions are commonly used as follows:

- (1) The typical whitening weight function is denoted as $f_j^k(x_j^k(1), x_j^k(2), x_j^k(3), x_j^k(4))$, and points $x_j^k(1), x_j^k(2), x_j^k(3), x_j^k(4)$, and is $f_j^k(\cdot)$.

Typical whitening weight functions can be described as piecewise functions as follows:

TABLE 4: A-B judgment matrix and indicator weight calculation.

A	B1	B2	Weight
B1	1	1/2	0.6667
B2	2	1	0.3333
Consistency test	$n \leq 2$, no conformance check is required		

TABLE 5: B1-C judgment matrix and indicator weight calculation.

B1	C1	C2	C3	Weight
C1	1	1	3	0.4434
C2	1	1	2	0.3874
C3	1/3	1/2	1	0.1692
Consistency test	$\lambda_{\max} = 3.0183$ CI = 0.0091 RI = 0.58 CR = 0.0158			

TABLE 6: B2-C judgment matrix and index weight calculation.

B2	C4	C5	C6	C7	Weight
C4	1	1/2	1/2	1/2	0.1364
C5	2	1	3	2	0.4269
C6	2	1/3	1	1	0.2073
C7	2	1/2	1	1	0.2294
Consistency test	$\lambda_{\max} = 4.1171$ CI = 0.0390 RI = 0.90 CR = 0.0434				

TABLE 7: C1-D judgment matrix and indicator weight calculation.

C1	D1	D2	D3	D4	Weight
DB	1	1/2	1/2	1/3	0.1194
D2	2	1	1	1/3	0.2008
D3	2	1	1	1/2	0.2222
D4	3	3	2	1	0.4577
Consistency test	$\lambda_{\max} = 4.0457$ CI = 0.0152 RI = 0.90 CR = 0.0169				

TABLE 8: C2-D judgment matrix and indicator weight calculation.

C2	D5	D6	Weight
D5	1	1/2	0.6667
D6	2	1	0.3333
Consistency test	$n \leq 2$, no conformance check is required		

TABLE 9: C3-D judgment matrix and index weight calculation.

C3	D7	D8	D9	D10	D11	D12	D13	Weight
D7	1	1/2	1/4	1/8	1/5	1/5	1/4	0.0324
D8	2	1	1/4	1/6	1/4	1/4	1/2	0.0484
D9	4	4	1	1/3	1/2	1/2	3	0.1381
D10	8	6	3	1	2	2	3	0.3287
D11	5	4	2	1/2	1	2	1/2	0.1739
D12	5	4	2	1/2	1/2	1	1/2	0.1426
D13	4	2	1/3	1/3	2	2	1	0.1358
Consistency test	$\lambda_{\max} = 7.6261$ CI = 0.0144 RI = 1.32 CR = 0.0791							

TABLE 10: C4-D judgment matrix and index weight calculation.

C4	D14	D15	D16	D17	D18	D19	Weight
D14	1	1/2	3	4	1/3	5	0.1866
D15	2	1	4	5	1/2	6	0.2824
D16	1/3	1/4	1	2	1/3	2	0.0882
D17	1/4	1/5	1/2	1	1/4	1	0.0546
D18	3	2	3	4	1	5	0.3391
D19	1/5	1/6	1/2	1	1/5	1	0.0491
Consistency test	$\lambda_{\max} = 6.2183$ CI = 0.0437 RI = 1.24 CR = 0.0352						

TABLE 11: C5-D judgment matrix and indicator weight calculation.

C5	D20	D21	D22	D23	Weight
D20	1	1/4	2	1/3	0.1268
D21	4	1	5	2	0.4492
D22	1/2	1/5	1	1/3	0.0848
D23	3	1/2	3	1	0.2891
Consistency test	$\lambda_{\max} = 4.0565$ CI = 0.0188 RI = 0.90 CR = 0.0209				

TABLE 12: C6-D judgment matrix and index weight calculation.

C6	D24	D25	D26	D27	D28	Weight
D24	1	1/2	2	5	4	0.2780
D25	2	1	3	6	5	0.4314
D26	1/2	1/3	1	3	2	0.1527
D27	1/5	1/6	1/3	1	1/2	0.0540
D28	1/4	1/5	1/2	2	1	0.0839
Consistency test	$\lambda_{\max} = 5.05475$ CI = 0.0137 RI = 1.12 CR = 0.0122					

TABLE 13: C7-D judgment matrix and indicator weight calculation.

C7	D29	D30	D31	D32	Weight
D29	1	1/2	2	3	0.2717
D30	2	1	3	5	0.4832
D31	1/2	1/3	1	2	0.1569
D32	1/3	1/5	1/2	1	0.0882
Consistency test	$\lambda_{\max} = 4.0145$ CI = 0.0048 RI = 0.90 CR = 0.0054				

$$f_j^k(x) = \begin{cases} 0, & x \notin [x_j^k(1), x_j^k(4)], \\ \frac{x - x_j^k(1)}{x_j^k(2) - x_j^k(1)}, & x \in [x_j^k(1), x_j^k(2)], \\ 1, & x \in [x_j^k(2), x_j^k(3)], \\ \frac{x_j^k(4) - x}{x_j^k(4) - x_j^k(3)}, & x \in [x_j^k(3), x_j^k(4)]. \end{cases} \quad (8)$$

- (2) The whitening weight function of the testing limit is written as $f_j^k[-, -, x_j^k(3), x_j^k(4)]$, and there are only turning points $x_j^k(3)$ and $x_j^k(4)$. The whitening weight function of the lower limit measure can be described as a piecewise function as follows:

$$f_j^k(x) = \begin{cases} 0, & x \notin [0, x_j^k(4)], \\ 1, & x \in [0, x_j^k(3)], \\ \frac{x_j^k(4) - x}{x_j^k(4) - x_j^k(3)}, & x \in [x_j^k(3), x_j^k(4)]. \end{cases} \quad (9)$$

- (3) The moderate limit whitening weight function is denoted as $f_j^k[x_j^k(1), x_j^k(2), -, x_j^k(4)]$, at which the turning points $x_j^k(2)$ and $x_j^k(3)$ coincide. Since the shape of the function image is triangular, it is often called the triangular whitening weight function.

The triangular whitening weight function can be described as a piecewise function as follows:

$$f_j^k(x) = \begin{cases} 0, & x \notin [x_j^k(1), x_j^k(4)], \\ \frac{x - x_j^k(1)}{x_j^k(2) - x_j^k(1)}, & x \in [x_j^k(1), x_j^k(2)], \\ \frac{x_j^k(4) - x}{x_j^k(4) - x_j^k(2)}, & x \in [x_j^k(2), x_j^k(4)]. \end{cases} \quad (10)$$

- (4) The whitening weight function of the upper limit measure is denoted as $f_j^k[x_j^k(1), x_j^k(2), -, -]$, and there is no turning point at this time, $x_j^k(3)$ and $x_j^k(4)$.

The upper bound measure whitening weight function can be described as a piecewise function as follows:

$$f_j^k(x) = \begin{cases} 0, & x < x_j^k(1), \\ \frac{x - x_j^k(1)}{x_j^k(2) - x_j^k(1)}, & x \in [x_j^k(1), x_j^k(2)], \\ 1, & x \geq x_j^k(2). \end{cases} \quad (11)$$

4.3. Application of Evaluation Model in Enterprise Human Resource Management. The most important aspect of human resource management is to evaluate personal achievements or performance. We assume that four aspects of personnel are invited to rate the performance of the

evaluator, namely, his customers, subordinates, colleagues, and leaders.

We take the human resource service institutions in W city as an example. The development of the institutions has begun to take shape, and the industry is in a stage of rapid development. As of December 31, 2016, 409 human resource service institutions in W city have participated in the annual inspection. In terms of geographical distribution, 248 institutions are mainly concentrated in region A and region B, accounting for 61% of the total number of institutions, while 161 institutions are located in other 9 districts and counties, accounting for 39% of the total number of institutions.

On the whole, the human resource service industry in W city started early, and the number of human resource service agencies has been increasing year by year (see Figure 2). According to its growth rate, it can be divided into three developmental stages.

The development of different types of institutions is uneven, with private enterprises in the majority.

According to the annual inspection report, all kinds of human resource service institutions in W city increased by 17.87% in 2016 compared with 2015, among which the number of public service institutions, industry-affiliated institutions, private nonenterprises, and Taiwan-funded enterprises decreased, while the number of state-owned enterprises and private enterprises increased. In 2016, private enterprises accounted for 73.8%, as shown in Figure 3.

According to the annual inspection, the number of employees in Xi'an human resource service institutions was 3468 in 2015, and 4372 in 2016, up 26.07% year on year. The number of people with a bachelor's degree or above is on the rise, up 37.16 % year on year, the number of people with a master's degree is up 35.9 % year on year, and the number of people with a college degree or below is down 12.01 % year on year, as shown in Figure 4.

Enterprise human resource management evaluation is a complex system composed of many elements. Each element in the system is not isolated from each other, but an organic dynamic system that influences, penetrates, and restricts each other. Therefore, a systematic analysis method should be adopted to analyze the effect of human resource management in construction enterprises. Based on the advantages and disadvantages of the common comprehensive evaluation methods, and considering the "grey characteristics" of human resource management of construction enterprises, this study introduces the grey clustering model of central triangular whitening weight function into the human resource management evaluation field of construction enterprises. The specific application process is as follows:

Step 1: We determine the evaluation grade and evaluation standard of each index and divide the evaluation grey category.

First of all, according to the effect evaluation objectives, drawing on the relevant literature and expert experience at home and abroad, the human resource management level of construction enterprises is divided

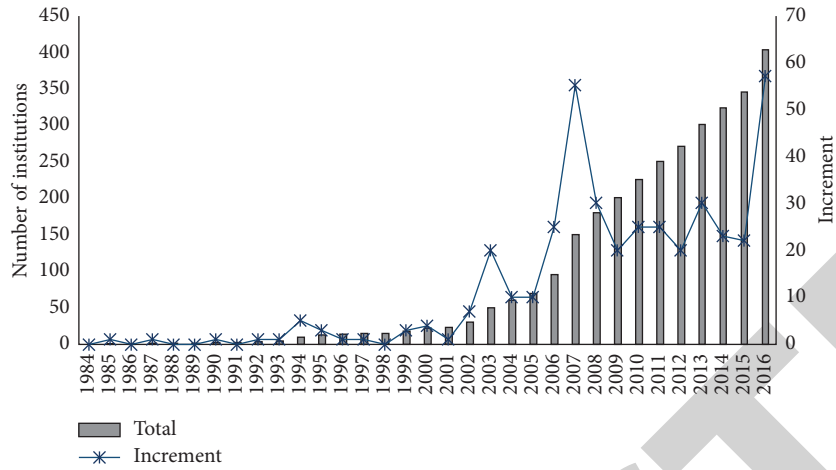


FIGURE 2: Increasing trend of the number of institutions.

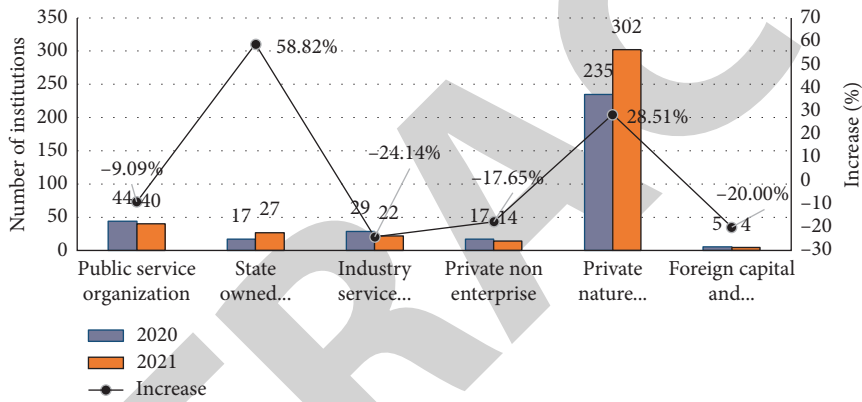


FIGURE 3: Comparison of the number of institutions in 2015 and 2016. The number of employees has significantly increased, but the structure is not very reasonable.

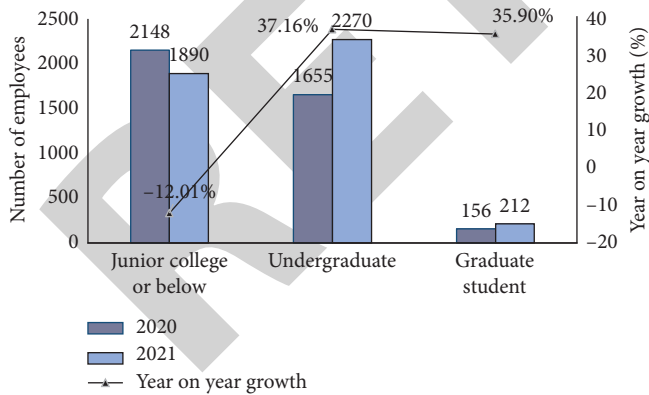


FIGURE 4: Educational structure of employees.

into five grades, that is, excellent, good, general, poor, and poor. Second, we establish the evaluation criteria of each factor in the index system. For quantitative indicators, we query industry information by looking at the statistical yearbook of China's construction industry, the Yearbook of Gansu Province, and looking for Internet information such as China construction network. At the same time, combined with the

reference value given by the existing research, so that the evaluation value can be given according to the industry overview in the evaluation process. For qualitative indicators, data were obtained through questionnaires. In order to accurately grasp the key points of scoring in practical evaluation, each qualitative indicator was divided into five grades according to the evaluation grade: excellent, good, general, poor, and poor. The human resource management level of construction enterprises is divided into five different categories. The so-called "excellent," "good," "general," "poor," and "poor" are essentially grey concepts, and the corresponding classification is also grey. Therefore, determining the grey class of evaluation is to determine the number of grey class grades of evaluation.

Step 2: We establish the triangular whitening weight function.

Combined with the actual situation of the study, the value range of each index grey class is extended, and 0 grey class and 6 grey class are added. Furthermore, the triangular whitening weight function of each index is constructed.

TABLE 14: Comprehensive evaluation.

Primary index	σ_{15}	σ_{14}	σ_{13}	σ_{12}	σ_{11}	Evaluation grade
Basic conditions	0.7891	0.5641	0.419	0.3569	0.4087	Excellent
Internal governance	0.8236	0.6741	0.5699	0.4987	0.5321	Excellent
Informatization level	0.3421	0.7891	0.5891	0.4577	0.6213	Good
Social responsibility	0.4451	0.5329	0.6394	0.4379	0.5582	Middle
Job performance	0.7574	0.5433	0.6321	0.3398	0.4278	Excellent
Target layer	0.7954	0.5681	0.6532	0.7439	0.4435	Excellent

Step 3: We investigate and sort out the actual value of indicators.

By collecting data from relevant departments, questionnaires, interviews, and other means, this study obtains the actual values of various indicators of the current situation of human resource management in construction enterprises, and quantifies these indicators through calculation formulas or expert scores.

Step 4: We calculate the trigonometric whitening weight function value of each index.

By substituting the realization values of each index of human resource management level of enterprises in W city into their respective trigonometric whitening weight functions, the whitening weight function values of each index corresponding to “excellent,” “good,” “general,” “poor,” and “poor” grey categories can be calculated.

Step 5: We calculate the comprehensive clustering coefficient.

According to formula (12), the comprehensive clustering coefficient of each grey class of the object to be evaluated can be calculated.

$$\sigma^k = \sum_{j=1}^m f_j^k(x_j) \cdot \eta_j. \quad (12)$$

According to the above calculation results, the evaluation level of basic conditions of the institution is “excellent,” indicating that the institution has complete legal person qualification and other licenses, and has good office conditions and service environment (see Table 14). The evaluation grade of the informatization level is “good,” indicating that the organization still has shortcomings in informatization construction. The evaluation grade of social responsibility is “medium,” indicating that the organization is not active in undertaking social responsibility. The evaluation level of internal governance is “excellent,” indicating that the internal organizational structure, rules, and regulations of the institution are sound, and the comprehensive quality of employees is high. The work performance evaluation grade is “excellent,” indicating that the organization’s current business benefits and service projects are good. Finally, the grey clustering coefficient of the target layer is calculated, and the comprehensive evaluation grade of the mechanism is “excellent,” indicating that the comprehensive development level of the mechanism is good.

5. Conclusions

As a strategic resource, human resources are very important to the sustainable development of enterprises. How to scientifically evaluate the contribution of human resource management to enterprise development has become an important issue concerned by academia and business circles. In view of the fact that there is a lot of grey information in the process of evaluating the effectiveness of strategic human resource management, this study applies the grey theory to the process of evaluating the effectiveness of strategic human resource management, provides new ideas and methods for studying the performance evaluation of strategic human resource management, and provides new theoretical guidance for enterprises to effectively evaluate the effectiveness of their human resource management.

The purpose of enterprise human resource management evaluation is to improve the evaluation that itself is a management tool. Through the implementation of evaluation activities, we can integrate and optimize human resource management functions, improve human resource policies, and promote the continuous improvement of management level, so as to make greater contributions to the realization of enterprise strategic objectives. Evaluation activity is the ultimate goal of the evaluation of the effect of human resource management in enterprises, and it is also the premise of the healthy and sustainable development of enterprises. Based on the relevant theories of human resource management, this study takes construction enterprises as an example and starts from the current situation and characteristics of human resource management of construction enterprises in China, constructs the index system suitable for the evaluation of human resource management effect of construction enterprises, and analyzes the comprehensive evaluation model by using the grey system theory.

Data Availability

The labeled datasets used to support the findings of this study are available from the author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

Acknowledgments

This work was supported by the Hebei Chemical & Pharmaceutical College.

Retraction

Retracted: Research on Fuzzy Control Method of Automobile Antilock Braking System

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. Fu, "Research on Fuzzy Control Method of Automobile Antilock Braking System," *Security and Communication Networks*, vol. 2022, Article ID 5001185, 9 pages, 2022.

Research Article

Research on Fuzzy Control Method of Automobile Antilock Braking System

Qiang Fu ^{1,2}

¹Shenyang Aerospace University, Shenyang 110136, Liaoning, China

²Liaoning General Aviation Research Institute, Shenyang 110136, Liaoning, China

Correspondence should be addressed to Qiang Fu; fuqiang@sau.edu.cn

Received 17 May 2022; Revised 30 May 2022; Accepted 18 June 2022; Published 8 July 2022

Academic Editor: Tao Cui

Copyright © 2022 Qiang Fu. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

The automobile Antilock Braking System (ABS) can prevent the wheel from locking by automatically adjusting the brake pressure at a high speed during emergency braking. While improving the braking effect of the car, it can also keep the steering ability of the car and ensure the safety of passengers. The automobile braking process has a strong nonlinearity and uncertainty, so exploring a simple and reliable control strategy is the focus of current research. Based on this, this paper proposes a variable-domain fuzzy proportional integral differential (PID) control strategy using a particle swarm optimization (PSO) algorithm to iteratively find the optimal theoretical domain. First, the PSO strategy is used to obtain the optimal regulation parameters. Then, the dynamic antiinterference ability of the control system is guaranteed by the variable theory domain fuzzy PID control, and the PID parameters and variable theory domain expansion factor are optimized by the PSO to increase the utilization degree of fuzzy rules initially set. Finally, compared with the traditional control strategy, the simulation and real vehicle test prove that the proposed system can significantly improve the control accuracy of abs. The proposed system has the advantages of small overshoot, short adjustment time, strong antiinterference ability, and practicability, which greatly improves the tracking performance of the ABS.

1. Introduction

The data on modern automobile accidents show that nearly 20% of the accidents are caused due to the faults of the Antilock Braking System (ABS). Therefore, it is of great significance to adopt a reasonable control strategy to achieve complete control in the shortest distance.

The Antilock Braking System (ABS) can avoid the phenomenon of tire locking when the wheel braking torque is large and plays a vital role in the safety of the vehicle [1]. It can not only prevent the front and rear wheels from being locked completely when braking and avoid slipping but also can shorten the braking distance and braking time, preventing excessive tire wear at the same time, and can improve the car in the braking process of handling stability and safety [2].

Because the road and vehicle conditions are complex, the braking process of the ABS is characterized by nonlinear, time-varying, and uncertainty. It is required that the braking

process can be fast, stable, and have strong disturbance rejection under the premise of ensuring the braking effect [3]. Moreover, ABS has high requirements for the quality of its control algorithm, and complex algorithms with slow response speed or poor antiinterference ability are not suitable for the ABS control [4]. At present, the ABS control algorithms mainly include logical threshold control [5], sliding mode variable structure control [6], PID control [7], and fuzzy control algorithm [8]. Each threshold value of the logic threshold controller needs to be determined by the repeated test, so it is difficult to debug. In literature [9], ADAMS and Simulink were used to test linear braking, and braking started at an initial speed of $100 \text{ km}\cdot\text{h}^{-1}$ on the road surface. It shows that the slip rate of ABS with a logic threshold controller fluctuates greatly during the whole braking process and cannot reach a stable state before complete braking. The sliding mode variable structure control algorithm has the advantages of simple structure and strong robustness, but it can only attenuate amplitude and

cannot completely remove chattering. In literature [6], braking was carried out at an initial speed of $90 \text{ km}\cdot\text{h}^{-1}$ on wet asphalt and dry asphalt but roads. The results show that compared with the ABS system based on sliding mode, the chattering of sliding mode is reduced effectively. However, the system lacks practical vehicle tests to verify its feasibility. Literature [10] uses a PID control algorithm to start braking at an initial speed of about $100 \text{ km}\cdot\text{h}^{-1}$ in MATLAB/Simulink environment and sets the target value of slip rate as 0.2. Simulation results show that with the extension of control time, the ABS system gradually reaches a stable state, but the overshoot is large and the response time is long, which does not meet the requirements of the ABS system fast and stable. Zha et al. [11] used CarSim and Simulink cosimulation to design the ABS system based on fuzzy control and started braking at an initial speed of $108 \text{ km}\cdot\text{h}^{-1}$. The results show that the response speed is fast in the braking process, but the fluctuation is large and lasts until the complete braking, and the designed fuzzy controller cannot make the system reach the best stable state. It can be seen that the control algorithms for ABS systems each have their own focus and drawbacks. By combining the respective advantages of different control algorithms and complementing each other, a more suitable controller for ABS systems can be designed. For example, a fuzzy PID controller can be designed by combining the advantages of the fast response speed of fuzzy control and good stability of PID control [12]. This system has been used in literature [13] to solve the problem of inaccurate target slip rate selection. The results show that the ABS system based on fuzzy PID control has a better control effect than the PID or fuzzy control.

Fuzzy PID is a control strategy developed after the birth of fuzzy cybernetics, which has been widely used in engineering [14]. Literature [15] proposed a new linear programming method for designing diagonal fuzzy PID controllers of two-input-two-output (TITO) systems and proposed a design method based on compensating characteristic trajectories. Experimental results show that linear programming improves the control efficiency of diagonal fuzzy PID. Literature [16] proposed the use of a genetic algorithm to design a fuzzy vehicle semiactive suspension magnetorheological damper PID control system; simulation results show that the control system has excellent vibration reduction.

Through the analysis of the braking process, it is found that the control of antilock braking is essentially the control of slip rate, which is easily affected by many uncertain factors such as speed, wheel speed, and road conditions. The ABS can avoid the phenomenon of tire locking when the wheel braking torque is large and improve the braking performance [17]. Existing cars are equipped with a standard traditional hydraulic ABS, which is mainly based on logic rules to realize the antilock braking function of tires. However, there are problems such as complicated logic and large workload of parameter adjustment (hereinafter referred to as "parameter adjustment") [18]. On the other hand, the electrification and intelligence of vehicles also promote the development of wire control systems [19] such as electro-hydraulic braking systems and electro-mechanical

braking systems. The braking torque can be adjusted continuously, and the linear control system as the actuator can transform the control problem of the ABS into a typical system control problem. Especially, the emergence of the wire control system promotes the technological innovation of the active braking system.

Although the ABS has made great progress in control strategies, different slip rate control strategies still have their own shortcomings [20]. The PID control strategy can achieve accurate tracking of slip rate through repeated adjustment, but the PID control parameters must be changed according to different vehicle types and different working conditions. The proposed fuzzy PID can improve the robustness but also increase the complexity of the control system [21]. As an effective control method to deal with the nonlinearity and robustness of ABS, sliding mode control still relies on the mathematical model of the ABS [22]. When the dynamic characteristics of the ABS are not modeled or the disturbance quantity is too large, the tracking response speed of the slip rate and the high-frequency tremor of braking torque restrict its application. The model predictive control (MPC) requires real-time matrix inversion, which is temporarily unable to be applied in real vehicles due to the limitation of computing chip hardware [23]. Although fuzzy control and neural network control can achieve the ideal control effect through debugging and training, the time and economic cost are too high, which also restrict the application in the ABS system. More importantly, under the emergency braking condition, the vehicle will be affected by external disturbance; how to realize the suppression of external disturbance plays a crucial role in the safety of emergency braking.

Traditional control strategy and optimization algorithms for complex ABS systems still have some limitations, including the immunity effect, there is no unified evaluation standard at present for the traditional control strategy, and the research lacks a large number of real vehicle tests [24]. Therefore, this paper designs an ABS control system based on the variable theory domain fuzzy PID structure method of particle swarm optimization to solve the optimal parameters. The simulation and real vehicle test show that this system has good effectiveness, robustness, and stability.

The main innovations of this paper are as follows:

- (1) An iterative optimization strategy using particle swarm optimization is proposed to obtain the optimal tuning parameters.
- (2) The dynamic antiinterference ability of the control system is guaranteed by variable theory domain fuzzy PID control, and the PID parameters and variable theory domain expansion factor are optimized by the particle swarm optimization algorithm to increase the utilization degree of fuzzy rules initially set.

This paper consists of five main parts: the first part is the introduction, the second part is state of the art, the third part is a methodology, the fourth part is the result analysis and discussion, and the fifth part is the conclusion.

TABLE 1: Typical values of each parameter for different road conditions.

Pavement	P1	P2	P3
Dry asphalt	1.3911	25.224	0.643
Wet asphalt	0.968	35.034	0.47
Cement	1.3083	26.402	0.6603
Dry cobblestone	1.4823	7.6905	0.7921
Wet cobblestone	0.5114	34.942	0.2434
Snow	0.3056	95.363	0.1876
Ice	0.161	307.624	0.124

2. State of the Art

In the process of braking, with the increase of braking torque, the tread and the ground will have a certain degree of relative sliding; that is, the wheel is in the state of rolling and sliding. If the braking torque continues to increase, the wheels will lock. The proportion of the sliding part in the wheel movement is expressed by the slip rate λ , and its formula is as follows:

$$\lambda = \frac{q - \omega R}{q}. \quad (1)$$

In the formula, q is the vehicle speed (unit: m/s), ω is the wheel rotation angular speed (unit: rad/s), and R is the wheel rolling radius (unit: m).

In this paper, the slip rate λ is used as the control object to study the ABS braking system. When the slip rate $\lambda = 0$, the adhesion coefficient $\mu = 0$, that is, the wheel is in a pure rolling state. As the braking torque increases, the wheel changes from a rolling state to a rolling and sliding state. At this time, the slip rate increases gradually, and the adhesion coefficient increases rapidly. When the slip rate increases to λ_0 , the maximum adhesion can be obtained, and the corresponding adhesion coefficient is μ_{\max} . Then, the adhesion coefficient decreases gradually with the increase of the slip rate λ . When the slip rate $\lambda = 1$, it is called wheel locking. The braking principle of automobile ABS is based on this curve characteristic, by adjusting the braking torque to obtain a larger ground-braking force.

The Burckhardt -tyre-road model can simulate the relationship between the slip rate and the adhesion coefficient under different road conditions. The Burckhardt μ - λ curve function is expressed as follows. And the typical values of each parameter for different road conditions are shown in Table 1.

$$\mu(\lambda) = c_1(1 - e^{-c_2\lambda}) - c_3\lambda, \quad (2)$$

$$\begin{cases} \lambda_z = \frac{1}{c_2} \log \frac{c_1 c_2}{c_3} \\ \mu(\lambda_z) = c_1 - \frac{c_3}{c_2} \left(1 - \log \frac{c_1 c_2}{c_3}\right) \end{cases}$$

3. Methodology

3.1. *Vehicle Dynamics Model.* The following is the vehicle 7-DOF dynamic mathematical model:

$$\begin{cases} w(\dot{q}_i - \gamma \cdot q_j) = (F_{ifl} + F_{irr})\cos\delta - (F_{jfl} + F_{jfr})\sin\delta + \\ F_{irl} + F_{irr} \\ w(\dot{q}_j + \gamma \cdot q_i) = (F_{ifl} + F_{ir})\sin\delta + (F_{jfl} + F_{jfr})\cos\delta + \\ F_{jrl} + F_{jrr} \\ X_k \cdot \dot{\gamma} = [(F_{ifl} + F_{ifr})\sin\delta + (F_{jfl} + F_{jfr})\cos\delta]g + \\ [(F_{ifr} - F_{ifl})\cos\delta + (F_{jfl} - F_{jfr})\sin\delta] \frac{n_{m1}}{2} + \\ (F_{irr} - F_{irl}) \frac{n_{m2}}{2} - (F_{jrl} + F_{jrr})h \\ Y\dot{\omega}_x = -R \cdot F_{ix} - N_{hx} + N_{dx} \end{cases}, \quad (3)$$

where δ is the front wheel angle, rad. q_i, q_j are longitudinal and transverse speeds respectively, m/s. γ is the yaw velocity, rad/s. $N_x = fl, fr, rl, rr$ corresponding to the left front wheel, the right front wheel, the left rear wheel, and the right rear wheel, respectively. ω_x is the angular velocity of each tire, rad/s. w is the vehicle mass, kg. $g = N + h$ is the wheelbase of the vehicle, m . n_{m1} is the front axle wheelbase, m . n_{m2} is the rear axle wheelbase, m . X_k is the vehicle around the k axis, $\text{kg}\cdot\text{m}^2$. b_a is the distance from the center of mass to the ground, m . R is the effective radius of the tire, m . N_{hx} and N_{dx} are braking torque and driving torque of each tire, respectively, N·m.

Since this paper mainly studies the slip rate control of the ABS, the linear control dynamic system is taken as the first-order inertia system, and its transfer function is as follows:

$$N_{hx}(s) = \frac{\omega_h}{s + \omega_h}. \quad (4)$$

In the formula, ω_h is the zero point of the transfer function of the linear control dynamic system, which is also the bandwidth of the actuator, rad/s.

3.2. *Tire Model.* To express the friction characteristics of tires and roads more accurately, a LuGre dynamic tire model was established, which can describe the jumping and hysteresis of friction.

$$\begin{cases} F_{lx} = (\sigma_{0l}k + \sigma_{1l}\dot{k} + \sigma_{2l}q_{rl})F_{Tx} \\ \dot{k}_l(\zeta, n) = q_{rl} - \left(\kappa_l R |\omega| + \frac{\sigma_{0l}|q_{rl}|}{\theta a(q_{rl})} \right) k_l(\zeta, n), \\ a(q_{rl}) = \mu_c + (\mu_s - \mu_c)e^{-|q_{rl}/q_s|} \end{cases} \quad (5)$$

where $L \in (i, j)$, ζ represents the coordinate axis, and α_x represents the sideslip angle of each tire. F_l is the friction between the tire and the road, N. σ_{0l} is rubber stiffness, m^{-1} . σ_{1l} is the rubber damping coefficient, s/m. F_{Tx} is the vertical load of the tire. $q_{rl} = R\omega - q_x$ is the relative velocity, m/s. q_x is the translation speed of the tire axle, m/s. κ_l is the pressure distribution coefficient and its value is $\kappa_l = 7/6w = 8.3$ m where w is the length of tire marks, m. θ is the road adhesion factor. μ_c is the coulomb friction. μ_s is the static friction force. q_s is the Stribeck velocity, m/s, which represents the switching speed of the two friction states.

The vertical load of each tire is shown as follows:

$$\begin{cases} F_{Tf} = wa \frac{h}{2N} - w\dot{q}_i \frac{b_a}{2N} - w\dot{q}_j \frac{b_a}{n_{m1}} \cdot \frac{h}{N} \\ F_{Tr} = wa \frac{h}{2N} - w\dot{q}_i \frac{b_a}{2N} + w\dot{q}_j \frac{b_a}{n_{m1}} \cdot \frac{h}{N} \\ F_{Tr} = wa \frac{g}{2N} + w\dot{q}_i \frac{b_a}{2N} - w\dot{q}_j \frac{b_a}{n_{m1}} \cdot \frac{g}{N} \\ F_{TTr} = wa \frac{g}{2N} + w\dot{q}_i \frac{b_a}{2N} + w\dot{q}_j \frac{b_a}{n_{m1}} \cdot \frac{g}{N} \end{cases} \quad (6)$$

The formula for the sideslip angle of each tier is as follows:

$$\begin{cases} \alpha_{fl} = \delta - \arctan\left(\frac{q_j + g\gamma}{q_i - (n_{m1}/2)\gamma}\right) \\ \alpha_{fr} = \delta - \arctan\left(\frac{q_j + g\gamma}{q_i + (n_{m1}/2)\gamma}\right) \\ \alpha_{rl} = -\arctan\left(\frac{q_j - h\gamma}{q_i - (n_{m2}/2)\gamma}\right) \\ \alpha_{rr} = -\arctan\left(\frac{q_j - h\gamma}{q_i + (n_{m2}/2)\gamma}\right) \end{cases} \quad (7)$$

The longitudinal speed of each wheel center in the wheel coordinate system is as follows:

TABLE 2: Motor parameters.

Parameter	Value
Maximum no-load speed t_0 (r.min ⁻¹)	125
Peak blocking current I_t (A)	3.5
Peak blocking torque T_t (N·m)	20
Armature resistance R (Ω)	1.75
Torque coefficient Z_n (Nm·A ⁻¹)	2
Maximum supply voltage U (V)	25
Continuous blocking torque T_g (N·m)	8
Continuous blocking voltage U_g (V)	8
Continuous blocking current I_g (A)	10
Armature inductance L (mH)	2.5
Rotational inertia J_w (kg·m ²)	0.005
Counter potential coefficient	0.2

$$\begin{cases} q_{fl} = \left(q_i - \frac{n_{m1}}{2} \gamma \right) \cos\delta + (q_j + g\gamma) \sin\delta \\ q_{fr} = \left(q_i + \frac{n_{m1}}{2} \gamma \right) \cos\delta + (q_j + g\gamma) \sin\delta \\ q_{rl} = q_i - \frac{n_{m2}}{2} \gamma \\ q_{rr} = q_i + \frac{n_{m2}}{2} \gamma \end{cases} \quad (8)$$

The slip rate of each wheel is as follows:

$$\begin{cases} \lambda_{fl} = \frac{\omega_{fl}R - q_{fl}}{q_{fl}} \\ \lambda_{fr} = \frac{\omega_{fr}R - q_{fr}}{q_{fr}} \\ \lambda_{rl} = \frac{\omega_{rl}R - q_{rl}}{q_{rl}} \\ \lambda_{rr} = \frac{\omega_{rr}R - q_{rr}}{q_{rr}} \end{cases} \quad (9)$$

3.3. Fuzzy Control Strategy. The dynamic antiinterference ability of the control system is guaranteed by the variable theory domain fuzzy PID control. The PID parameters and the variable theory domain expansion factor are optimized by the PSO algorithm to increase the utilization degree of fuzzy rules initially set. The motor parameters are shown in Table 2. In short, it is a method that uses an iterative particle swarm optimization strategy to obtain optimal tuning parameters.

The PSO algorithm is an optimization algorithm that is used to solve the best solution of the problem [25], which can obtain the optimal solution of the problem to be solved within a certain range. In the field of control, the PSO algorithm can

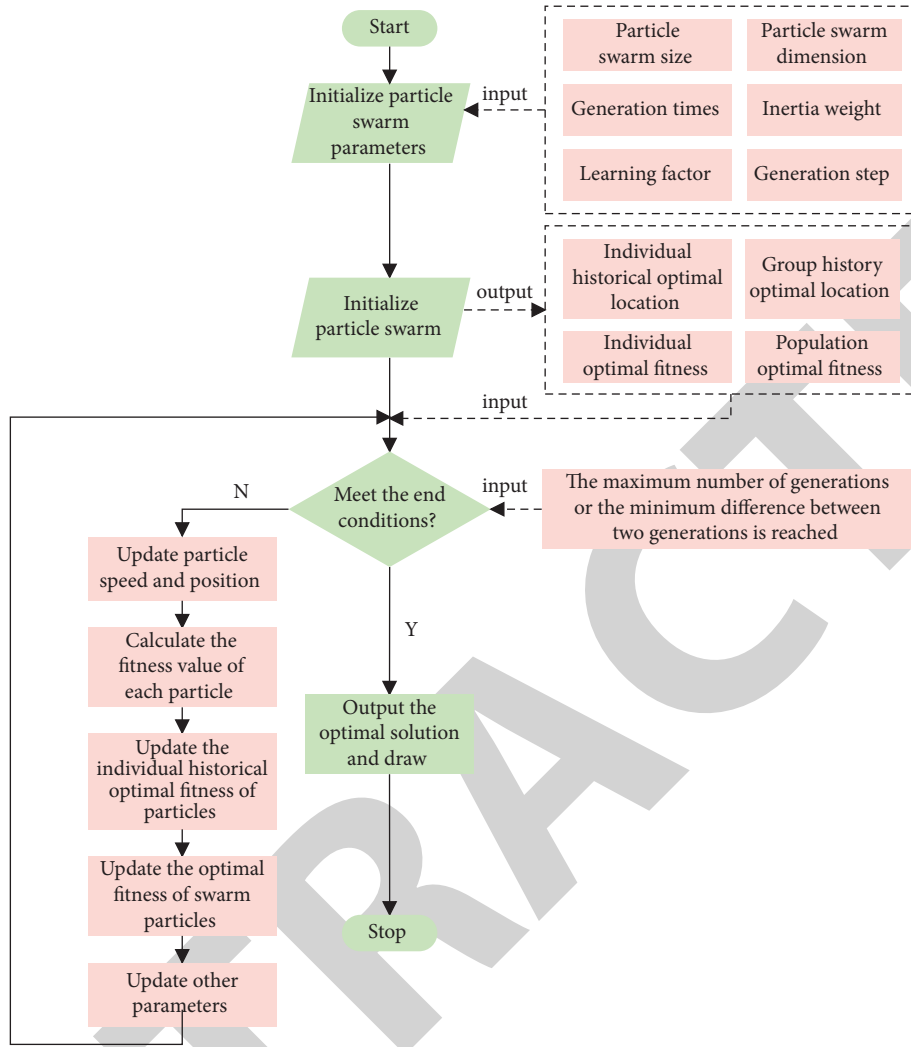


FIGURE 1: Particle swarm optimization process.

be combined with the PID controller to realize the dynamic adjustment of parameters [26]. Individuals can obtain group motion so that the solution of the problem is orderly and the best solution is obtained [27]. Figure 1 shows the flow chart of the particle swarm optimization algorithm applied in this paper. Firstly, the initial setting of optimization parameters is carried out. After initializing the particles, the positions and fitness of individuals and groups are calculated to determine whether the termination conditions are met. If so, the results are output; if not, the particles are updated to form iteration.

To judge the approximate degree of each particle value and theoretical solution, a reasonable evaluation index should be determined and adapted to the model characteristics of the torque motor. In this paper, the integral of the time-weighted absolute error (ITAE) is selected as a function to evaluate the degree of approximation between particle value and theoretical solution (particle swarm fitness). The expression of the ITAE index is as follows:

$$\text{ITAE: } s = \int_0^{\infty} e(n) |dn, \quad (10)$$

where $e(n)$ is the deviation between the actual value and the set value and n is the optimization time.

It can be seen from formula (12) that the ITAE index can be used as the characterization parameters of variables such as overshoot, adjustment time, and rise time. In this paper, the ITAE index is taken as a comprehensive evaluation factor to measure the control performance of the control process; that is, the particle swarm adaptation value reflects the situation of the comprehensive parameters such as overshoot, adjustment time, and rise time.

The fuzzy controller is a PID parameter self-tuning controller. At the same time, the expansion factors $\alpha(e)$ and $\alpha(EC)$ of input variables and $LK(m)$ ($m = P, I, D$) of output variables are dynamically adjusted by using the change rate of E and EC , to realize the automatic tuning of domain factors (see Figure 2).

According to the min-max reasoning criterion proposed by Xu et al. [20], the output of the weighted average solution after fuzzy processing is

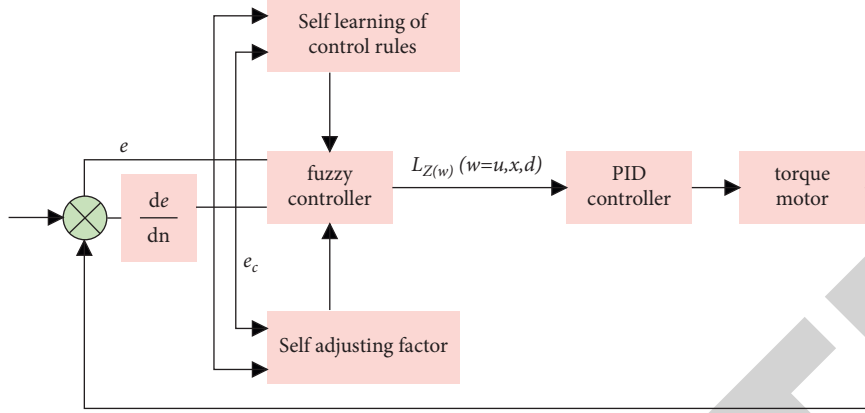


FIGURE 2: Variable domain structure of fuzzy PID.

$$\Delta Z_w = \frac{C_x \sum_x \mu_{C_1}(\Delta Z_{x(w)})}{\sum_x \mu_{C_1}(\Delta Z_{x(w)})}. \quad (11)$$

PID parameter setting formula is as follows:

$$\begin{aligned} Z_u &= Z_{u0} + \Delta Z_u, \\ Z_x &= Z_{x0} + \Delta Z_x, \\ Z_d &= Z_{d0} + \Delta Z_d, \end{aligned} \quad (12)$$

where Z_{u0} , Z_{x0} , and Z_{d0} are the initial set values of PID parameters. ΔZ_u , ΔZ_x , and ΔZ_d are dynamic setting values.

The actual output is as follows:

$$p(z) = Z_u e(z) + Z_x \sum_{x=1}^z e(x) + Z_d e_c(z). \quad (13)$$

To maximize the utilization of fuzzy rules and better optimize the control index, the input and output of fuzzy PID controller can be dynamically adjusted by scaling factor and scaling factor. For the quantization factor of the input variable, considering the maximum use of fuzzy rules, the principle of positive correlation between quantization factor and input variable is adopted, and the form widely used in the motor control field is selected from a variety of description methods: $\alpha = 1 - \lambda_1 e^{-z_1^2}$. For the proportional factor of output variables, combined with the influence of PID parameters on the control performance, the proportional factor of Z_u and Z_d is monotonically consistent with the error, and Z_x scale factor and error have a monotone inverse principle, to get the scale factor empirical formula. The empirical formula of expansion factor and scale factor summarized in this paper is shown in the following formula:

$$\begin{aligned} \alpha(e) &= 1 - \lambda_1 e^{-z_1^2}, \\ \alpha(e_c) &= 1 - \lambda_2 e^{-z_2^2}, \\ \beta(p_u) &= \lambda_3 |e|, \\ \beta(p_x) &= \frac{1}{|e| + \lambda_4}, \\ \beta(p_d) &= \lambda_5 |e|. \end{aligned} \quad (14)$$

Each parameter of formula (14) was obtained by the PSO algorithm. Using the PSO, the inertia factor is set as 0.6 and the acceleration constant is set as 2. In this paper, there are seven parameters $\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, z_1$, and z_2 in the expansion factor formula, plus three initial parameters Z_{u0}, Z_{x0} , and Z_{d0} of PID. The dimension is set as 10, the particle swarm size is set as 30, the maximum iteration number is set as 30, and the minimum adaptation value is set as 0. The maximum number of iterations and the minimum adaptive value can be used as the termination conditions of the algorithm. The offspring of particle swarm initialization is added to the ITAE index for solving, and the historical positions and fitness of individuals and groups are saved for termination judgment. If the termination conditions are not met, the parameters are reset for the next round of solving, to form iteration until the optimization termination conditions are reached.

3.4. ABS Control Mode. To make full use of the advantages of motor antilock braking, the control mode of the electric vehicle antilock braking was designed under the conditions of motor maximum braking strength K_{max} , maximum regenerative braking strength K_{reg} , and state of charge SOC.

At the start of braking, the braking strength demand at the brake pedal K is compared with the maximum braking strength of the motor K_{max} . If $K < K_{max}$, compare with the maximum regenerative braking strength K_{reg} ; otherwise, use hydraulic ABS braking. $K < K_{reg}$, indicating that there is a charging current, enters the state of charge judgment, otherwise directly starts the motor ABS braking. If $SOC < SOC_{max}$, motor ABS braking is conducted, otherwise hydraulic ABS braking is adopted.

4. Result in Analysis and Discussion

4.1. Simulation Experiment. The ABS performance is simulated and verified under different braking conditions using the proposed slip rate control method. Simulation parameters are shown in Table 3. White noise with a peak value of 1% of the output signal is added to the simulation process.

The bandwidth of the linear control system is set at 1s while linear braking ω_h is set at 20. Make the steering angle input a step signal of 0.2 rad, and simulate the high adhesion

TABLE 3: Simulation parameters.

Parameter	Value
w (kg)	2500
X_k ($\text{kg}\cdot\text{m}^2$)	2865
σ_{0l} (m^{-1})	195.5
n_{m2} (m)	1.85
b_g (m)	0.8
σ_{1l} (m^{-1})	0.95
n_{m1} (m)	1.75
Y ($\text{kg}\cdot\text{m}^2$)	1
q_s ($\text{m}\cdot\text{s}^{-1}$)	7.5
μ_c	0.9
h (m)	1.469
g (m)	1.365
A ($\text{m}\cdot\text{s}^{-2}$)	10
σ_{2l} ($\text{s}\cdot\text{m}^{-1}$)	0.002
X_m ($\text{kg}\cdot\text{m}^2$)	2.5
N (m)	2.955

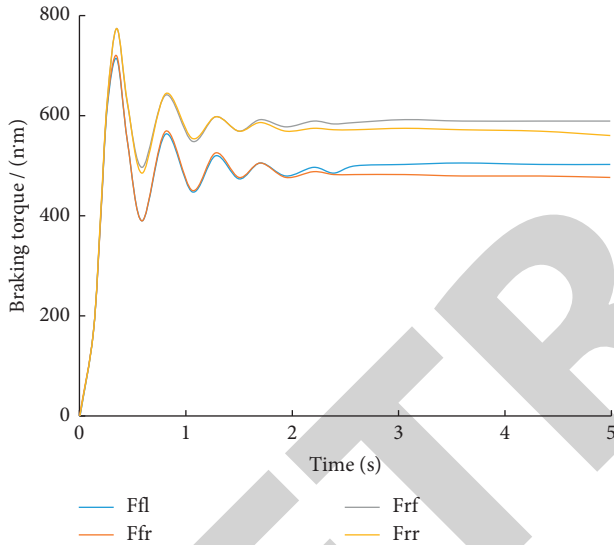


FIGURE 3: Braking torque curve during steering on low adhesion road.

road with the adhesion coefficient of 0.8 and the low adhesion road with the adhesion coefficient of 0.4, respectively.

The results are shown in Figures 3 and 4. The front wheel braking torque on a low adhesion road is stable around 600 N·m, and the rear wheel braking torque is stable around 500 N·m. On a high adhesion road surface, the front wheel braking torque is stable around 1 250 N·m, and the rear wheel braking torque is stable around 750 N·m. Since there is a step input of 0.2 rad at 1 s, the braking torque of the right wheel begins to be greater than that of the left wheel after 1 s, which conforms to the vehicle dynamics characteristics and verifies the correctness of the model.

4.2. Actual Vehicle Test and Analysis of ABS Braking Effect. To verify the ABS active disturbance rejection control effect, the ABS PID brake controller and the braking controller in this paper are designed, and the active disturbance rejection

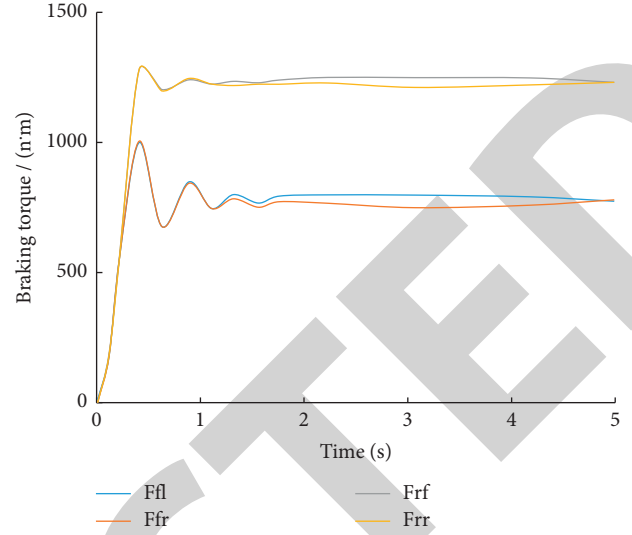


FIGURE 4: Braking torque curve during steering on high adhesion road.

TABLE 4: Vehicle parameters.

Length, width, height (mm)	2850, 1320, 1880
Wheelbase (mm)	2050
Wheel radius R (mm)	0.5
Vehicle mass W (kg)	1500
Rated power P (kW)	5
Maximum speed v_{\max} ($\text{km}\cdot\text{h}^{-1}$)	50
Driving form	Rear wheel drive
Power form	AC

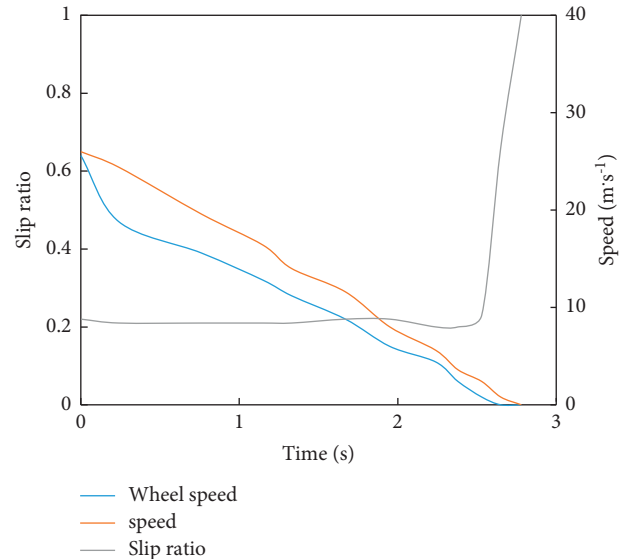


FIGURE 5: Braking performance based on the proposed controller.

controller is installed in the test vehicle. The vehicle parameters are shown in Table 4.

The smooth road test scheme is as follows: the test vehicle starts braking at the initial speed of $25 \text{ m}\cdot\text{s}^{-1}$ on the cement road with no load.

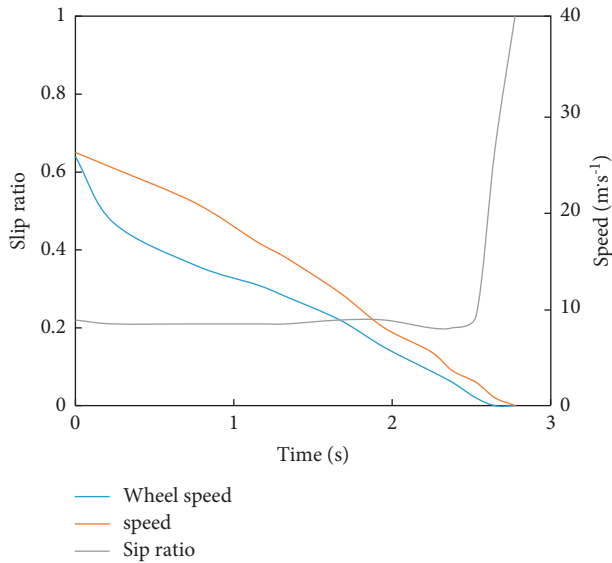


FIGURE 6: Braking performance based on PID controller.

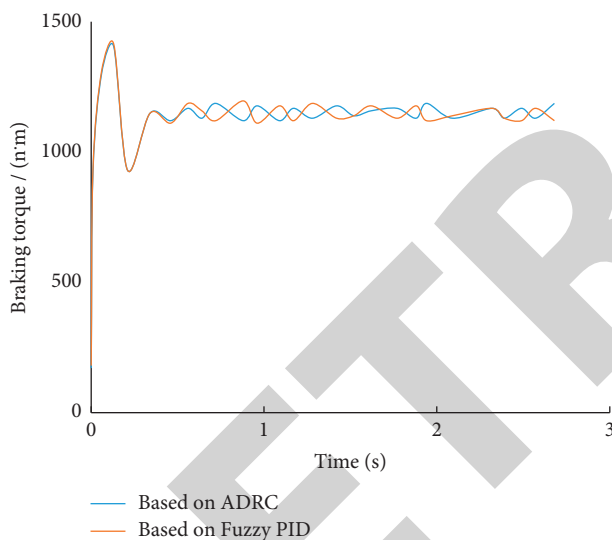


FIGURE 7: Comparison of braking torque between the proposed controller and PID controller.

The docking road test scheme was as follows: the test vehicle was unloaded, started braking at the initial speed of $25 \text{ m}\cdot\text{s}^{-1}$ on the ice surface, and drove 20 m to the cement road surface.

The speed, wheel speed, slip rate, and braking torque of the smooth road test are shown in Figures 5–7.

The final braking distance and final braking time of the real vehicle test are extracted from Figures 5–7, as shown in Table 5.

It can be seen from Figures 5–7 that the measured braking test results of cement pavement are very close to the simulation results of typical cement pavement with the optimal slip rate of 0.2. The test verifies that fuzzy PID control based on the variable theory domain has shorter final braking distance, less final braking time, and better braking performance than ABS based on PID control. It can be seen

TABLE 5: Simulation and experimental results of final braking distance and final braking time.

Parameter	Simulation data		Experimental data	
	Proposed	PID	Proposed	PID
Final braking time (s)	2.731	2.886	2.828	3.022
Final braking distance (m)	34.55	38.34	36.11	40.38

from Table 5 that the test data are slightly larger than the simulation data, mainly because the optimal slip rate of cement pavement used in real vehicle tests is slightly greater than 0.2. Figures 5–7 and Table 5 verify the correctness of the simulation models and simulation results.

5. Conclusion

The Antilock Braking System can improve the braking performance of vehicles in extreme conditions, but the braking system has the characteristics of uncertainty, time variability, and nonlinear. To ensure the handling stability and safety of automobile braking and further realize the optimal control of antilock braking systems under various working conditions, this paper designed a set of automobile antilock braking control systems based on variable theory domain fuzzy PID. The simulation experiment and real vehicle test of the system, respectively, show that the designed control system can effectively reduce chattering and has good effectiveness, robustness, and stability. Although the designed system has strong robustness and is suitable for vehicle driving, some problems need to be improved: (1) the ABS simulation system is not perfect enough. This paper adopts a relatively simple model to build the ABS simulation model, and it is more ideal. (2) The analysis of test road conditions is not comprehensive enough. Special braking conditions such as ramp parking and bend braking have not been involved. How to recognize the complex road conditions and design the road recognition module to act on the tyre model will become an important problem to further improve the model. The next research focus will be to analyze the braking performance of the vehicle comprehensively and ensure the safety and handling stability of the vehicle through braking simulation and tests of various scenarios.

Data Availability

The labeled dataset used to support the findings of this study is available from the corresponding author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

Acknowledgments

This study was sponsored by the Basic Scientific Research Project of <https://doi.org/10.13039/501100007620%20theEducation> Department of Liaoning Province:

Retraction

Retracted: The Impact of Intelligent Accounting Information Management on Corporate Governance Information Transparency

Security and Communication Networks

Received 26 December 2023; Accepted 26 December 2023; Published 29 December 2023

Copyright © 2023 Security and Communication Networks. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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. He, "The Impact of Intelligent Accounting Information Management on Corporate Governance Information Transparency," *Security and Communication Networks*, vol. 2022, Article ID 2478926, 13 pages, 2022.

Research Article

The Impact of Intelligent Accounting Information Management on Corporate Governance Information Transparency

Baiyu He 

Chengdu Normal University, School of Economics and Management, Chengdu 61130, Sichuan, China

Correspondence should be addressed to Baiyu He; 121077@cdnu.edu.cn

Received 5 May 2022; Revised 30 May 2022; Accepted 10 June 2022; Published 7 July 2022

Academic Editor: Tao Cui

Copyright © 2022 Baiyu He. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

In order to improve the transparency of corporate governance information, this paper combines intelligent accounting information technology to analyze the information transparency in the process of corporate governance, analyzes the fast adaptive neighbor clustering algorithm, and realizes the joint spectral embedding of data by creating block diagonal anchor graphs. Moreover, this paper re-selects anchor points from the spectral embedding data and constructs a new block diagonal anchor graph. In addition, using the principle of adaptive nearest neighbor clustering, this paper performs structured graph learning on the block diagonal anchor graph matrix. After derivation, the Laplace eigenvalue decomposition problem of the whole graph in adaptive nearest neighbor clustering can be transformed into a block matrix singular value decomposition problem. The regression analysis shows that there is a linear correlation between the advanced degree of intelligent accounting information management technology and the transparency of corporate governance information.

1. Introduction

Among corporate information transparency, accounting information transparency is a very important and particularly critical component. Moreover, improving the transparency of corporate accounting information can significantly improve the quality of corporate information and greatly reduce the behavior of “adverse selection” in in-app purchases. In addition, accounting information plays an irreplaceable and important role in the finance of enterprises, especially listed companies, as well as business operators. The public judges the financial situation of the enterprise through the accounting information of the enterprise. For a long time, financial information fraud has occurred frequently, so improving the transparency of corporate accounting information is still an urgent problem to be solved. The study of this topic has far-reaching and important significance for maintaining the normal market economic order and protecting the rights and interests of investors.

In the process of economic development, the role of capital is very important. Not only in the external capital market, but also in the internal market, capital plays a very important role in the allocation of internal resources. In the process of research on ICM by foreign scholars, the research focus is mainly set on the existence, efficiency, enterprise organization structure, and the relationship between equity results and so on. China’s research on ICM is relatively in its infancy. However, although the research on ICM in China started relatively late, the development speed is very fast.

Most scholars believe that ICM plays an important role in alleviating corporate financing constraints. At the same time, in the process of researching ICM, scholars have also paid full attention to issues such as rent-seeking, agency behavior, and management incentives. Many scholars have also deeply studied the problem of ICM resource allocation efficiency and have achieved some research results in the research process [1]. On the one hand, the research of ICM has very ideal theoretical value, and on the other hand, it has practical significance to promote the improvement and

improvement of ICM of group enterprises. Therefore, in the research process of this paper, the research perspective is locked on the problem of internal capital market efficiency allocation. The research on accounting information transparency has long attracted the attention of many scholars at home and abroad. At this stage, domestic and foreign scholars have made a lot of definitions, but they have not yet reached a consensus and have not formed a conclusion [2]. Usually, people think that the transparency of accounting information and the quality of accounting information are closely related. The higher the transparency of the former, the lower the information cost investors need in the investment process. A relatively high information cost is required. Therefore, in the process of reducing or reducing adverse selection behavior in the capital market, improving the transparency of accounting information can be said to be an effective way [3]. The management of accounting information is an integral part of the corporate governance structure. For the improvement of the quality of accounting information, the management of accounting information is an indispensable guarantee. The corporate governance mechanism can be reflected through the corporate governance language of accounting and can promote the corporate governance function to maximize its function [4]. There is a great degree of correlation between corporate governance and transparency of accounting information, and the effectiveness of the former can ensure the authenticity and integrity of the latter. Corporate governance will cause differences in the quality of accounting information, and on this basis, the transparency of accounting information will be reflected [5].

Accounting information transparency, as an important component in the study of corporate transparency, has become another hot issue in academia in recent years. However, neither foreign nor domestic companies have reached a consensus on the meaning of accounting information transparency [6]. The study defines transparency as "Public disclosure of reliable and timely information helps information users to accurately evaluate a bank's financial status and performance, business activities, risk distribution and risk management practices" [7]. The discussion concluded that: "To achieve transparency, timely, accurate, relevant and adequate qualitative and quantitative disclosures must be provided, and these disclosures must be based on sound measurement principles". The quality characteristics of transparent information include comprehensiveness, relevance, timeliness, reliability, comparability, and significance [8]. Pu defines the concept of "opaqueness" as "the lack of clear, accurate, formal, easy-to-understand and generally recognized conventions in the fields of commercial economy, fiscal finance, government regulation, etc.". According to this statement, the information transparency of listed companies can be understood as "clear, accurate, formal, easy to understand and generally recognized" [9]. Reference [10] defines the degree to which the reported accounting earnings cannot provide information about the real economic earnings of the enterprise as earnings opacity. Literature [11] believes that "The information quality characteristics of financial reports can be divided into two

categories: one is the quality of financial statement content; the other is the quality of financial statement presentation and disclosure in other financial reports". Literature [12] believes that accounting information transparency is a comprehensive and comprehensive concept that includes accounting information quality standards, information disclosure and supervision, and the formulation and implementation of accounting standards. Reference [13] defines the transparency of accounting information as the degree to which an enterprise's accounting earnings reflect the real economic earnings, or the degree to which investors can see through the enterprise's behavior through the enterprise's accounting information. Highly transparent accounting information should have a higher information content. It can reduce the information cost of investors.

The research of literature [14] shows that the stock price of the company will increase with the increase of the transparency of accounting information, that is, investors are more aware of the company with higher information disclosure standards and higher transparency, and are willing to buy its stock, so that its stock price is relatively high. The literature [15] believes that the problem of information asymmetry and agency conflict between external investors and enterprise management can be alleviated by providing authentic financial reports and improving information disclosure. Literature [16] studies the relationship between accounting transparency and cost of capital, and the results show that the cost of capital will decrease with the increase of accounting transparency. It is believed that the more stable the level of information disclosure, the more conducive to improving the liquidity of corporate stocks. Reference [17] selected the research results to show that the degree of information disclosure of enterprises is positively correlated with company value and business performance. In the literature [18], the research on voluntary disclosure of information by enterprises believes that the internal and external governance mechanisms of enterprises have obvious complementary effects. Literature [19] studies the relationship between the level of corporate information disclosure and the cost of refinancing, and the results show that the improvement of the level of disclosure can help reduce the cost of corporate refinancing. Reference [20] confirms the results from the perspective of the financial ratios and the degree of disclosure of earnings information of enterprises. The results show that enterprises with higher debt ratios tend to disclose early earnings forecasts, while companies with high return on assets are more inclined to conduct forward-looking earnings information. Literature [21] studies the impact of listed companies' accounting information disclosure on the forecasts of securities analysts. The empirical results show that the transparency of accounting information is positively correlated with the accuracy of securities analysts' forecasts. Literature [22] adopts an empirical method to confirm that there is a positive correlation between the transparency of accounting information of listed companies and the size of the board of directors, and there is no significant correlation with the proportion of external directors.

At present, researchers' understanding of accounting information transparency has gradually become more consistent, focusing on the key points of financial information transparency, from only focusing on the quality of partial accounting information to focusing on the protection of investors' interests, and at the content level, it also extends to the disclosure of the superior company. All information is concerned because investors can understand the essence of the enterprise through the appearance of enterprise accounting information. However, there is still no unified standard to measure accounting information transparency in academia. The research on accounting information transparency will lead to different results with different measurement methods. However, the research on accounting information transparency is very important because real and effective accounting information is the cornerstone of building an advanced capital market. However, the more information disclosed by listed companies is not the better, and the timeliness and effectiveness of the disclosed information should also be considered. Throughout the domestic and foreign scholars' research on accounting transparency, their measurement of accounting information transparency can be roughly attributed to two methods: one is to directly use the disclosure evaluation of authoritative organizations as a variable to measure information transparency and build your own transparency index to measure.

This paper combines intelligent accounting information technology to analyze the information transparency in the process of corporate governance to improve the efficiency of information management in the process of corporate governance, effectively improve the management efficiency of modern companies, and improve the operational efficiency of corporate financial management.

2. Intelligent Accounting Information Processing

In the fast clustering of accounting information, the discretization of fast embedded data plays an important role in the discovery of cluster structure. The traditional method is to use the k-means method to discretize the spectral embedded data, and there is still room for further improvement in the clustering accuracy. In this chapter, using the FCAG algorithm to describe the similarity between data points, an improved fuzzy clustering algorithm based on the FCAG algorithm is proposed and applied to the fast embedded data discretization of accounting information to improve the clustering accuracy.

2.1. FCAG Algorithm. The fuzzy weight of the objective function of FCM is set to 1, the objective function can be written as

$$\min_{y_i=1, Y \geq 0, m_j} \sum_{i=1}^n \sum_{j=1}^c y_{ij} \|x_i - m_j\|_2^2. \quad (1)$$

Among them, y_{ij} represents the fuzzy membership degree between the data point x_i and the cluster center m_j .

When the input data are replaced with the fast spectral threshold input data U , problem (1) can be expressed as

$$\min_{y_i=1, Y \geq 0, m_j} \sum_{i=1}^n \sum_{j=1}^c y_{ij} \|u_i - m_j\|_2^2. \quad (2)$$

It can be seen from formula (2) that the size of fuzzy membership depends on the distance between the spectral embedded data and its cluster center. In order to improve the accuracy of the fuzzy membership matrix, inspired by the literature, a similarity measure in the needle graph space can be added to formula (2).

w_{il} is an element of the i th row and l -column of the needle graph matrix W . The larger the value of the element, the closer the data points u_i and u_j are. Because the fuzzy membership vector y_i describes the distance relationship between the data point u_i and all cluster centers, when the data points u_i and u_j are adjacent to each other, their fuzzy membership vectors are also close. Therefore, formula (2) can be rewritten as

$$\min_{y_i=1, Y \geq 0, m_j} \sum_{i=1}^n \sum_{j=1}^c y_{ij} \|u_i - m_j\|_2^2 + \frac{\lambda}{2} \sum_{i=1}^n \sum_{l=1}^n w_{il} \|y_i - y_l\|_2^2. \quad (3)$$

Among them, λ is the regularization parameter. The regular term adds the similarity measure in the needle graph space, which can make the fuzzy membership matrix more accurately describe the relationship between the data and the cluster centers.

In spectral clustering, the Laplace matrix has the following properties:

$$Tr(Y^T LY) = \frac{1}{2} \sum_{i=1}^n \sum_{l=1}^n w_{il} \|y_i - y_l\|_2^2, \quad (4)$$

$$\text{s.t. } Y^T Y = I.$$

By fusing formulas (3) and (4), the objective function can be rewritten as

$$\min_{y_i=1, Y \geq 0, Y^T Y = I, m_j} \sum_{i=1}^n \sum_{j=1}^c y_{ij} \|u_i - m_j\|_2^2 + \lambda Tr(Y^T LY). \quad (5)$$

The update of fuzzy membership in objective function (5) has profound physical meaning. It is not only affected by the distance between the fast spectral embedding data and the cluster center but also constrained by the similarity between the cluster data in the graph domain. The new objective function can combine the advantages of FCM and spectral clustering to obtain a better fuzzy membership matrix.

The objective function (5) preserves the probability constraints of fuzzy membership and does not require additional information in the process of constructing similarity graphs.

The objective function (5) is solved by alternate iteration method. Since the objective function has two variables (cluster center M and fuzzy membership matrix Y), this is a nonconvex problem. Therefore, when solving the objective function, one of the variables needs to be fixed to update the other variable.

- (1) Fix Y to update M

When Y is fixed, formula (5) can be rewritten as

$$\min_M \sum_{i=1}^n \sum_{j=1}^c y_{ij} \|u_i - m_j\|_2^2. \quad (6)$$

For each cluster center m_j , there are

$$\min_{m_j} \sum_{i=1}^n y_{ij} \|u_i - m_j\|_2^2 \quad (j = 1, 2, \dots, c). \quad (7)$$

When formula (7) is differentiated with respect to m_j and set equal to 0, the closed-form solution of m_j is

$$m_j = \frac{\sum_{i=1}^n y_{ij} u_i}{\sum_{i=1}^n y_{ij}} \quad (j = 1, 2, \dots, c). \quad (8)$$

- (2) Fix M to update Y

When M is fixed, formula (5) can be rewritten as

$$\min_{y_i=1, Y \geq 0, Y^T Y = I} \sum_{i=1}^n \sum_{j=1}^c y_{ij} \|u_i - m_j\|_2^2 + \lambda \text{Tr}(Y^T \tilde{L} Y). \quad (9)$$

When $d_{ij}^m = \|u_i - m_j\|_2^2$, formula (9) is rewritten as

$$\min_{y_i=1, Y \geq 0, Y^T Y = I} \sum_{i=1}^n \sum_{j=1}^c y_{ij} d_{ij}^m + \lambda \text{Tr}(Y^T \tilde{L} Y). \quad (10)$$

By constructing matrix $D^m, d_{ij}^m \in D^m$, formula (10) can be written in matrix form:

$$\min_{y_i=1, Y \geq 0, Y^T Y = I} \text{Tr}(Y^T D^m) + \lambda \text{Tr}(Y^T \tilde{L} Y). \quad (11)$$

Considering probability constraints, inequality constraints and orthogonal constraints, the Lagrangian function of optimization problem (11) is

$$\begin{aligned} L(Y, \gamma, \alpha, \beta) &= \text{Tr}(Y^T D^m) + \lambda \text{Tr}(Y^T \tilde{L} Y) \\ &+ \frac{\gamma}{2} \|Y^T Y - I\|_F^2 + \text{Tr}(\alpha Y^T) \\ &+ \frac{\beta}{2} \|Y C - E\|_F^2. \end{aligned} \quad (12)$$

Among them, γ is the penalty parameter to ensure the orthogonality of the fuzzy membership matrix Y , α is the Lagrange multiplier, and β is the regular term parameter to ensure that the row sum of the fuzzy membership matrix is 1. The matrix elements of matrix $C \in \mathbb{R}^{c \times n}, E \in \mathbb{R}^{n \times n}$ are all 1s. Taking the

derivative of Y by formula (12) and setting its derivative to 0, we can get:

$$D^m + 2\lambda \tilde{L} Y + \gamma Y Y^T Y + \alpha + \beta Y C C^T = \gamma Y + \beta E C^T. \quad (13)$$

When formula (9) is used to construct the bipartite graph matrix \tilde{Z} of fast spectral embedded data, then the anchor graph matrix is

$$\tilde{W} = \tilde{Z} \tilde{\Lambda}^{-1} \tilde{Z}^T. \quad (14)$$

Thus, the Laplace matrix is

$$\tilde{L} = I - \tilde{W} = I - \tilde{Z} \tilde{\Lambda}^{-1} \tilde{Z}^T. \quad (15)$$

Substituting \tilde{L} in formula (15) into formula (13), we get:

$$\begin{aligned} D^m + 2\lambda Y + \gamma Y Y^T Y + \alpha + \beta Y C C^T \\ = \gamma Y + 2\lambda \tilde{Z} \tilde{\Lambda}^{-1} \tilde{Z}^T Y + \beta E C^T. \end{aligned} \quad (16)$$

According to the Karush-Kuhn-Tuckre (KKT) condition, there is $\alpha^o Y = 0$, which represents the Hadamard product. Using the multiplicative update rule, the optimization method of formula (16) is

$$y_{ij}^{t+1} = y_{ij}^t \frac{\left(\gamma Y^t + 2\lambda \tilde{Z} \tilde{\Lambda}^{-1} \tilde{Z}^T Y^t + \beta E C^T \right)_{ij}}{\left(D^m + 2\lambda Y^t + \gamma Y^t (Y^t)^t Y^t + \beta Y^t C C^T \right)_{ij}}. \quad (17)$$

M and Y are iteratively updated until the objective function (5) converges.

- (3) The clustering category of the data can be easily obtained according to the following formula:

$$l_i = \text{argmax}_{j \in \{1, 2, \dots, c\}} \frac{y_{ij}}{1^T y_j}. \quad (18)$$

We assume that the input data is $X \in \mathbb{R}^{n \times d}$, where n and d represent the data volume and data dimension, respectively. In the fast spectral embedding stage, its time complexity is $O(nm_1 d t + nm_1 d + nm_1 k + n_1^2 k)$. In the fuzzy discretization stage of fast spectral embedded data, its time complexity is $O(nm_1 c t_1 + nm_1 c + (nc^2 + n^2 c) t_2)$. Among them, n_1 and k represent the number of data points and the number of neighbors, respectively, and t, t_1 and t_2 represent the needle points selected from the original data by the k-means method. The k-means method selects needle points from the fast spectral embedding data and iterates the fuzzy clustering process, and c is the number of clustering categories. Although the time complexity of FCAG is lower than that of spectral clustering $O(n^2 c + n^2 d)$, it still has a quadratic relationship with the amount of data.

2.2. FANSEC Clustering Algorithm. In this paper, the construction method of anchor graph is introduced, which uses the second-order state transition probability of data points

and anchor points to describe the relationship between data points and data points in the graph domain. Inspired by the joint clustering composition method, an adjacency graph matrix is constructed by the first-order state transition probabilities of data points and anchor points. In the composition of the joint clustering, the similarity graph structure is in the form of a block matrix, and the values of the input data represent the connections between data points and features. Joint clustering can achieve the effect of clustering data points and features of data points at the same time. Similarly, the first-order state transition probability from the data point to the anchor point (or the anchor point to the data point) represented by the bipartite graph Z is used as the connection relationship to form the graph at the subdiagonal position of the graph, which is described by the formula as follows:

$$W = \begin{bmatrix} 0 & Z \\ Z^T & 0 \end{bmatrix}. \quad (19)$$

Since this composition method is generated based on data points and needle points and is a block diagonal matrix, for the convenience of description, this kind of graph structure is called block diagonal needle diagram. From the knowledge of spectral clustering, the objective function of the normalized cut graph can be expressed as

$$\min_{F_W^T F_W = I} \text{Tr}(F_W^T L_W F_W). \quad (20)$$

Among them, $L_W = I - D_W^{-1/2} W D_W^{-1/2}$ is the normalized Laplacian matrix of the block diagonal pin graph. The matrices F_W and D_W are represented in the following form:

$$F_W = \begin{bmatrix} U \\ \bar{U} \end{bmatrix}, D_W = \begin{bmatrix} D_{W1} & 0 \\ 0 & D_{W2} \end{bmatrix}. \quad (21)$$

Formula (20) can be transformed into the solution:

$$\max_{U^T U + \bar{U}^T \bar{U} = I} \text{Tr}(U^T D_{W1}^{-1/2} Z D_{W2}^{-1/2} \bar{U}). \quad (22)$$

In order to solve U and \bar{U} , a lemma is introduced.

Lemma 1. *If $M \in \mathbb{R}^{n \times m}$, $G \in \mathbb{R}^{n \times c}$, $H \in \mathbb{R}^{n \times m}$ is assumed, the solution of the optimization problem is $G = \sqrt{2}/2V_1$, $H = \sqrt{2}/2V_2$.*

$$\max_{G^T G + H^T H = I} \text{Tr}(G^T M H). \quad (23)$$

Among them, V_1 and V_2 are the left and right singular value vectors corresponding to the largest c singular values after M singular value decomposition.

The proof of Lemma 1 can be found in the literature. According to Lemma 1, U and \bar{U} are, respectively, the left and right singular value vectors corresponding to the largest c singular values after the decomposition of matrix $D_{A1}^{-1/2} Z D_{A2}^{-1/2}$ multiplied by $\sqrt{2}/2$. According to the definition, the physical meaning of U is the spectral embedded data of the data points that have not been discretized, and the physical meaning of \bar{U} is the spectral embedded data of the pin points that have not been discretized. So far, we have

obtained the joint spectral embedding results of data points and pinpoints. Spectral embedding data can be directly discretized using methods such as k-means to obtain final results. However, the clustering results based on k-means discretization methods are usually unstable and suboptimal. In order to obtain better clustering results, this chapter adopts the method of data spectral embedding combined with other clustering algorithms for data clustering.

We assume that \tilde{U} is a pinpoint selected from the spectral embedding data U using the k-means method. The data U and the needle points \hat{U} form a new data set $\tilde{U} = [U, \hat{U}]^T$, $\tilde{U} \in \mathbb{R}^{(n+n_1) \times c}$, where n_1 is the number of needle points. Referring to the definition of the block diagonal matrix, the composition of the data set \tilde{U} is S , and its element values satisfy:

$$\begin{cases} s_{ij} \geq 0, \tilde{u}_i \in U, \tilde{u}_j \in \hat{U} \text{ or } \tilde{u}_i \in \hat{U}, \tilde{u}_j \in U, \\ s_{ij} = 0, \text{ otherwise.} \end{cases} \quad (24)$$

Formula (24) is written in the form of a block diagonal matrix:

$$S = \begin{bmatrix} 0 & P \\ P^T & 0 \end{bmatrix}, S \in \mathbb{R}^{(n+n_1) \times (n+n_1)}. \quad (25)$$

According to the traditional adaptive nearest neighbor rule, a large value of s_{ij} corresponds to a small distance $\|\tilde{u}_i - \tilde{u}_j\|_2^2$, which can be described as the following problem:

$$\begin{aligned} \min_S \sum_{i=1}^{n+n_1} \sum_{j=1}^{n+n_1} \left(\|\tilde{u}_i - \tilde{u}_j\|_2^2 s_{ij} \right) + \gamma \|S\|_F^2 \\ \text{s.t. } 0 \leq s_{ij} \leq 1, s_i \mathbf{1} = 1. \end{aligned} \quad (26)$$

Among them, s_i represents the i th row vector of matrix S . The second term in formula (26) is the regular term, and γ is the regularization parameter. In the clustering process, the ideal composition S is that the number of its connected domains is equal to the number of cluster categories. However, in most cases, only graph structures with a connected domain of 1 can be obtained by solving formula (26).

If the similarity matrix \tilde{S} is assumed to have c connected domains, then its normalized Laplacian matrix $\tilde{L}_{\tilde{S}} = I - D_{\tilde{S}}^{-1/2} \tilde{S} D_{\tilde{S}}^{-1/2}$ has the following properties:

Theorem 1. The number of zero eigenvalues of the Laplace matrix $\tilde{L}_{\tilde{S}}$ is equal to the number of connected domains of the similarity matrix \tilde{S} .

According to Theorem 1, the number of nonzero eigenvalues of a matrix $\tilde{L}_{\tilde{S}}$ is equal to the rank of the matrix. In order to obtain \tilde{S} with c connected domains, we add a rank constraint to formula (26).

$$\begin{aligned} \min_S \sum_{i=1}^{n+n_1} \sum_{j=1}^{n+n_1} \left(\|\tilde{u}_i - \tilde{u}_j\|_2^2 s_{ij} \right) + \gamma \|S\|_F^2 \\ \text{s.t. } 0 \leq s_{ij} \leq 1, s_i \mathbf{1} = 1, \text{rank}(\tilde{L}_{\tilde{S}}) = (n + n_1) - c. \end{aligned} \quad (27)$$

However, the optimization problem (27) with added rank constraints is still difficult to solve. We assume that

$\sigma_k(\tilde{L}_S)$ represents the k -th smallest eigenvalue of \tilde{L}_S . Since \tilde{L}_S is a positive semi-definite matrix, $\sigma_k(\tilde{L}_S) \geq 0$. Problem (27) can be transformed into:

$$\min_S \sum_{i=1}^{n+n_1} \sum_{j=1}^{n+n_1} \left(\|\tilde{u}_i - \tilde{u}_j\|_2^2 s_{ij} \right) + \gamma \|S\|_F^2 + \lambda \sum_{k=1}^c \sigma_k(\tilde{L}_S) \quad (28)$$

$$\text{s.t. } 0 \leq s_{ij} \leq 1, s_i \mathbf{1} = 1.$$

When the parameter λ is large enough, formulas (28) and (27) are equal.

According to KyFan's theorem, we have:

$$\sum_{k=1}^c \sigma_k(\tilde{L}_S) = \min_{F \in \mathbb{R}^{(n+1) \times c}, F^T F = I} \text{Tr}(F^T \tilde{L}_S F). \quad (29)$$

Then, problem (28) can be rewritten as

$$\min_{S, F} \sum_{i=1}^{n+n_1} \sum_{j=1}^{n+n_1} \left(\|\tilde{u}_i - \tilde{u}_j\|_2^2 s_{ij} \right) + \gamma \|S\|_F^2 + \lambda \text{Tr}(F^T \tilde{L}_S F) \quad (30)$$

$$\text{s.t. } 0 \leq s_{ij} \leq 1, s_i \mathbf{1} = 1, F \in \mathbb{R}^{(n+n_1) \times c}, F^T F = I.$$

Compared with equation (27) and (30) is obviously easier to solve. Observing problem (30), we can see that there are two variables S and F that need to be optimized, which can be solved by alternately updating the two variables.

(1) Fix S to update F

When S is fixed, formula (30) can be rewritten as

$$\min_{F \in \mathbb{R}^{(n+n_1) \times c}, F^T} \text{Tr}(F^T \tilde{L}_S F). \quad (31)$$

Among them, $\tilde{L}_S = I - D_S^{-1/2} S D_S^{-1/2}$ is the normalized Laplacian matrix and F and D_S represent the form of the block matrix:

$$F = \begin{bmatrix} \bar{F} \\ \tilde{F} \end{bmatrix}, D = \begin{bmatrix} D_{S1} & 0 \\ 0 & D_{S2} \end{bmatrix}. \quad (32)$$

Substituting $\tilde{L}_S = I - D_S^{-1/2} S D_S^{-1/2}$ and (32) into (31), we get:

$$\max_{\substack{\bar{F} \\ \tilde{F} \\ \bar{F} + \tilde{F} = I}} \text{Tr}(\bar{F}^T D_{S1}^{-1/2} P D_{S2}^{-1/2} \tilde{F}). \quad (33)$$

According to Lemma 1, the F matrix can be updated by singular value decomposition of matrix $D_{S1}^{-1/2} S D_{S2}^{-1/2}$.

(2) Fix F to update S

When F is fixed, formula (30) can be rewritten as

$$\min_S \sum_{i=1}^{n+n_1} \sum_{j=1}^{n+n_1} \left(\|\tilde{u}_i - \tilde{u}_j\|_2^2 s_{ij} \right) + \gamma \|S\|_F^2 + \lambda \text{Tr}(F^T \tilde{L}_S F)$$

$$\text{s.t. } 0 \leq s_{ij} \leq 1, s_i \mathbf{1} = 1. \quad (34)$$

Considering that the Laplace matrix \tilde{L}_S has the following properties:

$$\text{Tr}(F^T \tilde{L}_S F) = \frac{1}{2} \sum_{i=1}^{n+n_1} \sum_{j=1}^{n+n_1} \left\| \frac{f_i}{\sqrt{d_i}} - \frac{f_j}{\sqrt{d_j}} \right\|_2^2 s_{ij}. \quad (35)$$

Substituting (35) into (34), we get:

$$\min_S \sum_{i=1}^{n+n_1} \sum_{j=1}^{n+n_1} \left(\|\tilde{u}_i - \tilde{u}_j\|_2^2 + \gamma s_{ij} + \alpha \left\| \frac{f_i}{\sqrt{d_i}} - \frac{f_j}{\sqrt{d_j}} \right\|_2^2 \right) s_{ij}$$

$$\text{s.t. } 0 \leq s_{ij} \leq 1, s_i \mathbf{1} = 1. \quad (36)$$

Among them, the parameter $\alpha = \lambda/2$.

Considering the definition of similarity graph matrix S in (25), formula (36) can be rewritten as

$$\min_S \sum_{i=1}^n \sum_{j=n+1}^{n+n_1} \left(\|\tilde{u}_i - \tilde{u}_j\|_2^2 + \gamma s_{ij} + \alpha \left\| \frac{f_i}{\sqrt{d_i}} - \frac{f_j}{\sqrt{d_j}} \right\|_2^2 \right) s_{ij}$$

$$+ \sum_{i=n+1}^{n+n_1} \sum_{j=1}^n \left(\|\tilde{u}_i - \tilde{u}_j\|_2^2 + \gamma s_{ij} + \alpha \left\| \frac{f_i}{\sqrt{d_i}} - \frac{f_j}{\sqrt{d_j}} \right\|_2^2 \right) s_{ij}$$

$$\text{s.t. } 0 \leq s_{ij} \leq 1, s_i \mathbf{1} = 1. \quad (37)$$

Since

$$\sum_{i=1}^n \sum_{j=n+1}^{n+n_1} \left(\|\tilde{u}_i - \tilde{u}_j\|_2^2 + \gamma s_{ij} + \alpha \left\| \frac{f_i}{\sqrt{d_i}} - \frac{f_j}{\sqrt{d_j}} \right\|_2^2 \right) s_{ij}$$

$$= \sum_{i=n+1}^{n+n_1} \sum_{j=1}^n \left(\|\tilde{u}_i - \tilde{u}_j\|_2^2 + \gamma s_{ij} + \alpha \left\| \frac{f_i}{\sqrt{d_i}} - \frac{f_j}{\sqrt{d_j}} \right\|_2^2 \right) s_{ij}. \quad (38)$$

Formula (37) can be rewritten as

$$\min_S \sum_{i=1}^n \sum_{j=n+1}^{n+n_1} \left(\|\tilde{u}_i - \tilde{u}_j\|_2^2 + \gamma s_{ij} + \alpha \left\| \frac{f_i}{\sqrt{d_i}} - \frac{f_j}{\sqrt{d_j}} \right\|_2^2 \right) s_{ij}$$

$$\text{s.t. } 0 \leq s_{ij} \leq 1, s_i \mathbf{1} = 1. \quad (39)$$

The updates of each row s_i in formula (39) are independent of each other, so we can optimize each row separately. Problem (39) is equivalent to optimization:

$$\min_{s_i} \sum_{j=n+1}^{n+n_1} \left(\|\tilde{u}_i - \tilde{u}_j\|_2^2 + \gamma s_{ij} + \alpha \left\| \frac{f_i}{\sqrt{d_i}} - \frac{f_j}{\sqrt{d_j}} \right\|_2^2 \right) s_{ij}$$

s.t. $0 \leq s_{ij} \leq 1, s_i \mathbf{1} = 1.$

(40)

$l_{ij}^u = \|\tilde{u}_i - \tilde{u}_j\|_2^2, l_{ij}^f = \|(f_i/\sqrt{d_i}) - (f_j/\sqrt{d_j})\|_2^2, l_{ij} = l_{ij}^u + \alpha l_{ij}^f$, then formula (40) can be rewritten as

$$\min_{s_i} \left\| s_i + \frac{1}{2\gamma} l_i \right\|_2^2,$$

s.t. $0 \leq s_{ij} \leq 1, s_i \mathbf{1} = 1.$

(41)

It can be proved that the optimal update method of s_{ij} is

$$s_{ij} = \left(-\frac{l_{ij}}{2\gamma_i} + \eta \right)_+.$$
(42)

Among them, γ, γ_i , and η are Lagrange multipliers, and their solution methods are

$$\gamma_i = \frac{k}{2} l_{i,k+1} - \frac{1}{2} \sum_{j=1}^k l_{ij}, \gamma = \frac{1}{n} \sum_{i=1}^n \gamma_i,$$
(43)

$$\eta = \frac{1}{k} + \frac{1}{2k\gamma_i} \sum_{j=1}^k l_{ij}.$$

Among them, k is the number of neighbors. So far, we have obtained the closed-form solution of the S-optimized update in equation (34).

- (3) Iteratively update F and S until the objective function (29) converges.

We assume that the input data are $X \in \mathbb{R}^{n \times d}$, where n and d represent the data volume and data dimension, respectively. The time complexity of the clustering method proposed in this chapter mainly includes two parts. n_1, t, k , and t_1 represent the number of pinpoints, the number of k-means clustering iterations, the number of neighbors, and the number of optimization iterations, respectively. The time complexity mainly includes two aspects, data joint spectral embedding and fast adaptive nearest neighbor clustering based on block diagonal needle graph.

- (1) Data joint spectral embedding
- The time complexity required to select n_1 needle points from the data points using the k-means method is $O(nm_1 dt)$;
 - The time complexity required to obtain the bipartite graph matrix Z between the data point and the pin point is $O(nm_1 d)$;
 - The time complexity of the singular value decomposition of $D_{A1}^{-1/2} Z D_{A2}^{-1/2}$ is $O(nm_1 k + n_1^2 k)$.

- (2) Fast adaptive neighbor clustering based on block diagonal matrix graph

- The time complexity required to select n_1 pinpoints from the fast spectral embedding data U using the k-means method is $O(nm_1 ct)$; a.
- The time complexity required to initialize the matrix S is $O(nm_1 c)$;
- The time complexity required for the iterative update process is $O((n_1^3 + n_1^2 n + m_1 k)t_1)$.

3. Analysis of the Impact of Intelligent Accounting Information Management Algorithm on Corporate Governance Information Transparency

The development characteristics selected in this paper include growth and volatility. Financial characteristics describe the performance of a listed corporate in a specific period, and the information it conveys is quite useful to stakeholders. The financial characteristics selected in this paper include profitability, financial risk, and loss in the previous year. Figure 1 shows the relationship between the above-mentioned corporate characteristics and accounting information transparency, which has also become the basic analytical theoretical framework for this paper to study and verify this issue.

This article combines the supply chain of corporate financial reporting and the information transformation process (Figure 2) in the capital market to understand the meaning of accounting transparency. Under the modern corporate system nurtured by the capital market, the separation of powers has resulted in information asymmetry, which has resulted in a supply and demand mechanism for information.

The corporate's internal and external governance mechanisms and the macro institutional environment have an impact on disclosure benefits and disclosure costs. In addition, management disclosure decisions are also influenced by its own motivations and corporate characteristics. Figure 3 describes the influencing factors of information transparency and its mechanism of action.

Because accounting information has economic consequences, the provision of accounting information cannot be simply a technical issue, or accounting transparency can be achieved only by relying on a set of clear and scientific accounting standards. The realization of accounting transparency can only be expected when the relevant accounting environment can guarantee the quality of accounting information and the quality of disclosure. Moreover, a healthy corporate governance ecology can be used as a constraint and supervision mechanism to restrict the disclosure of accounting information of listed companies and ensure the high quality of accounting information. Its impact on accounting transparency can be shown in Figure 4.

The internal and external supervision mechanism of the corporate is an important check on the quality of accounting

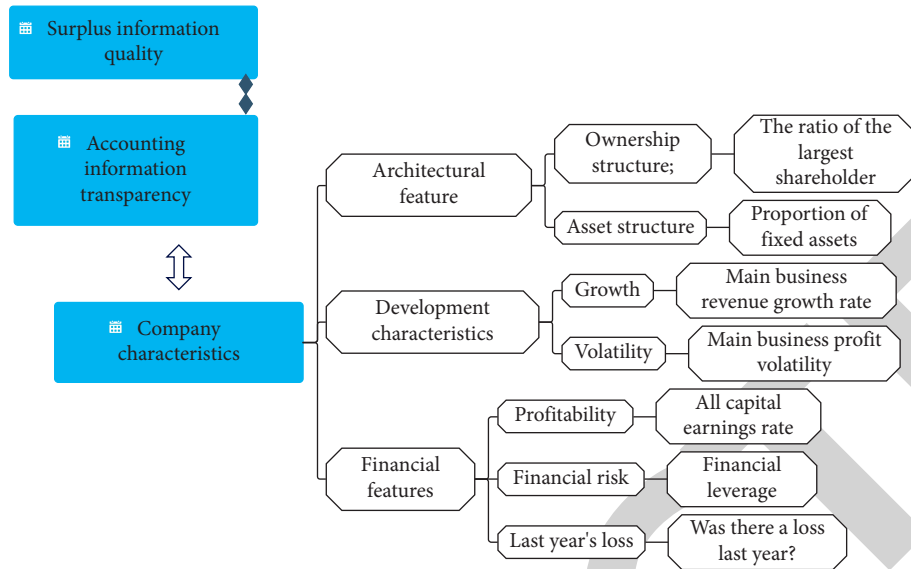


FIGURE 1: Analysis framework of factors affecting accounting information transparency based on corporate characteristics.

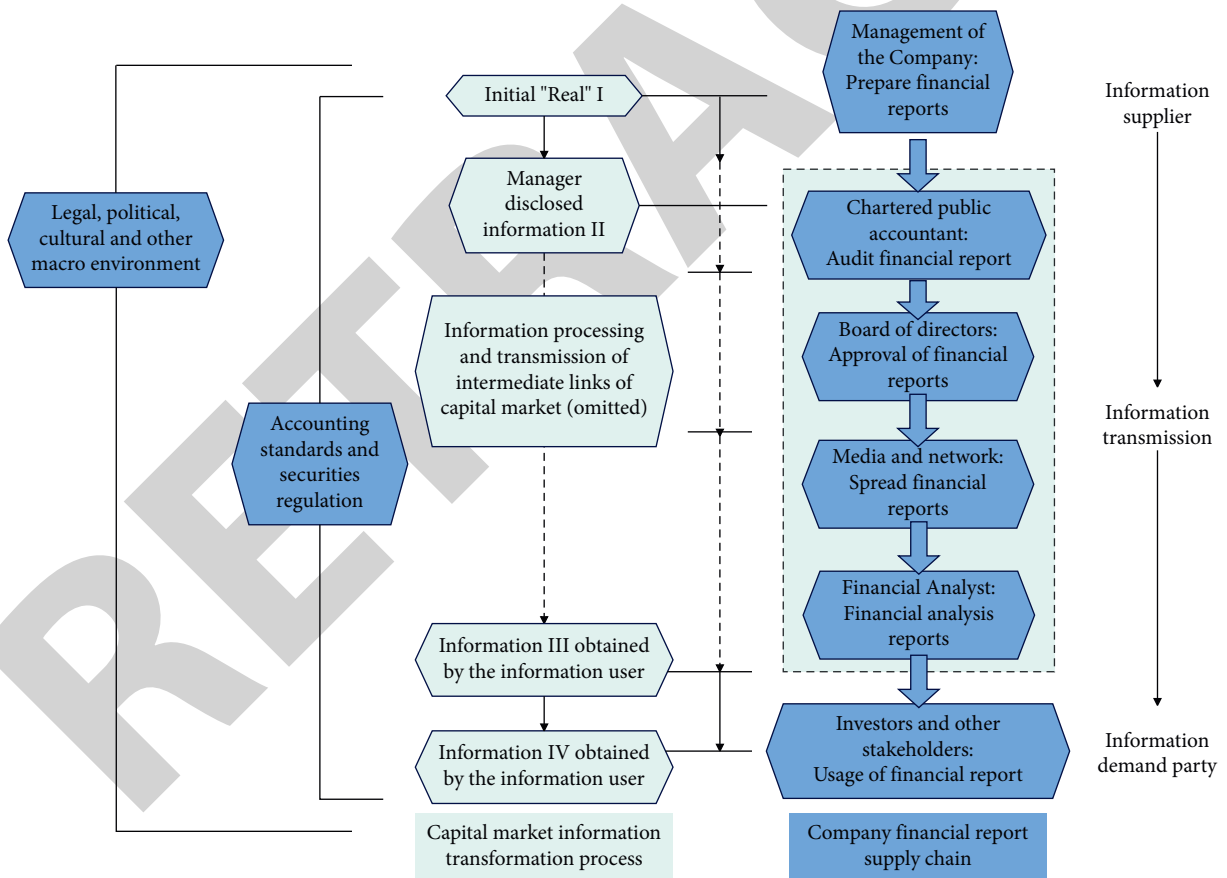


FIGURE 2: Information transfer diagram of capital market.

information. If the supervision mechanism cannot operate effectively, it will seriously affect the transparency of accounting information. Figure 5 specifically lists the intermediate supervision links of listed companies' accounting information from management to users.

Management takes into account the impact of cost-benefit factors and rational brokerage assumptions that seek to avoid disadvantages. On the one hand, it may conceal internal control deficiencies. On the other hand, with the expansion of the power of the management, for the

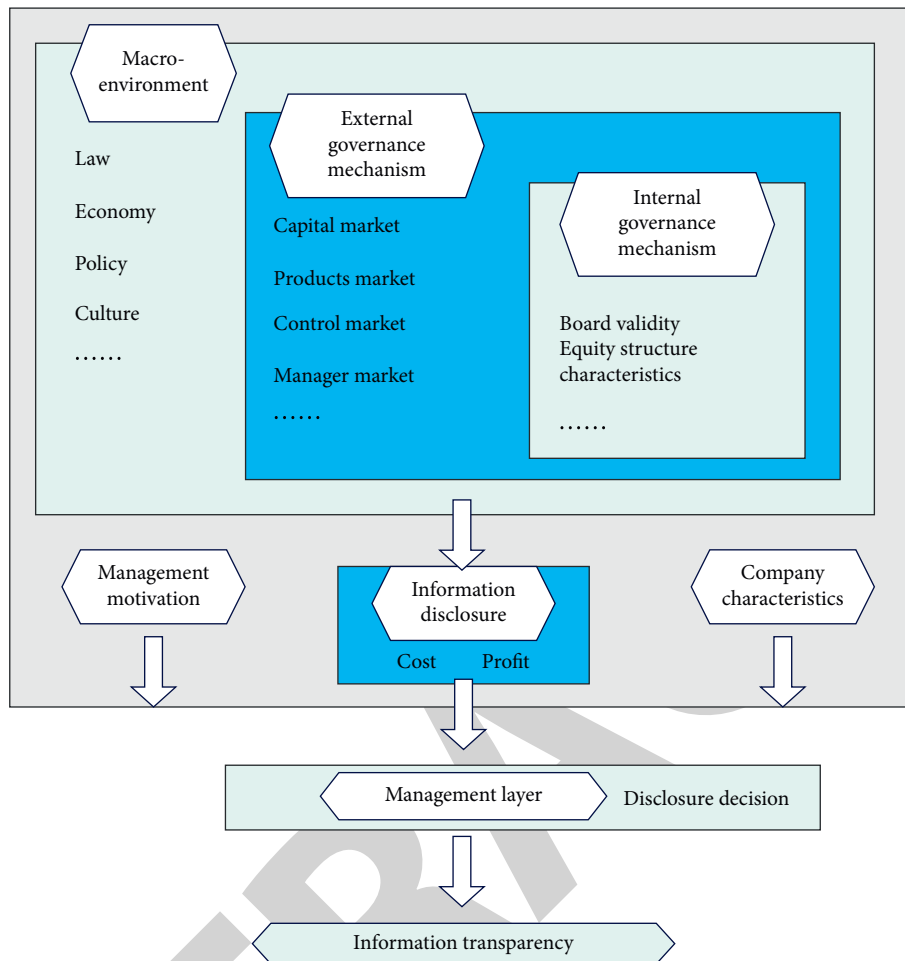


FIGURE 3: Influencing factors and mechanism of information transparency.

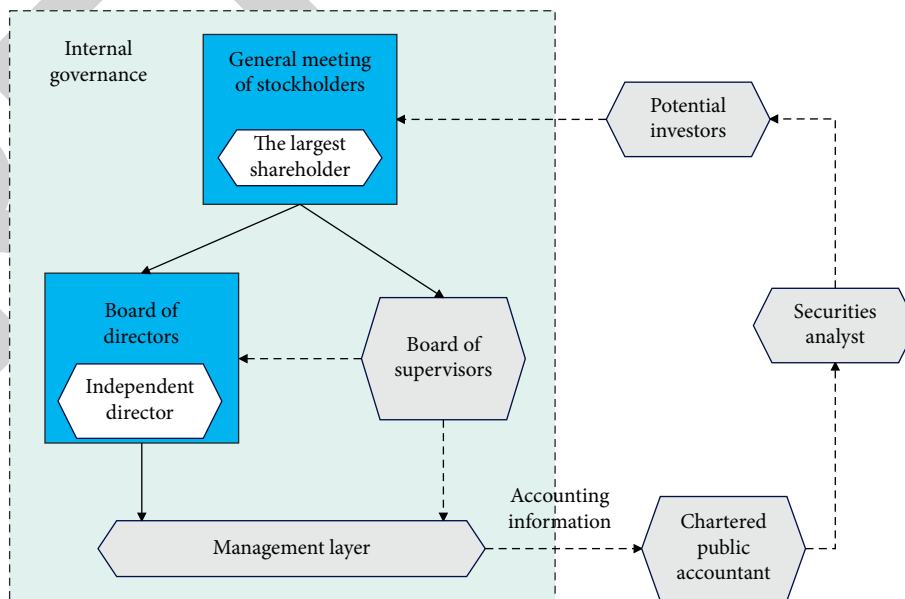


FIGURE 4: The impact of corporate governance ecology on accounting transparency.

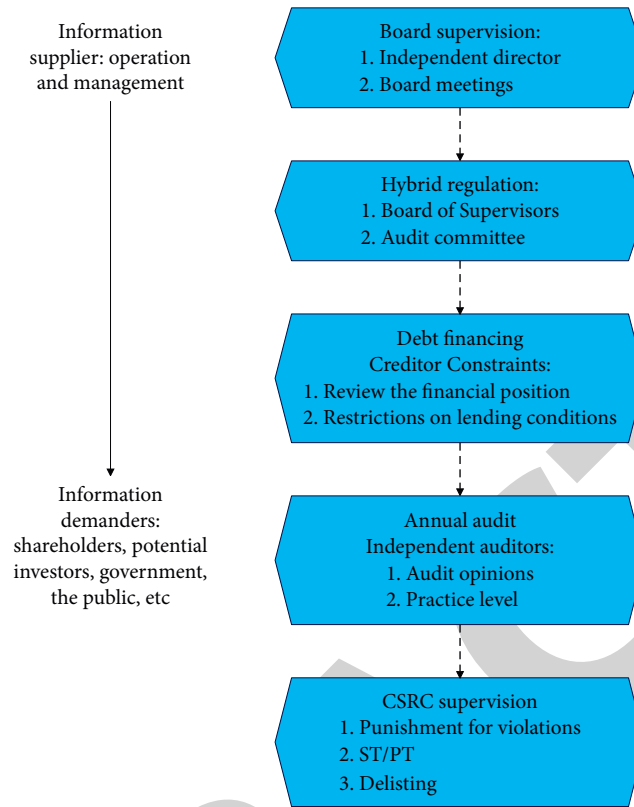


FIGURE 5: Quality control link of accounting information.

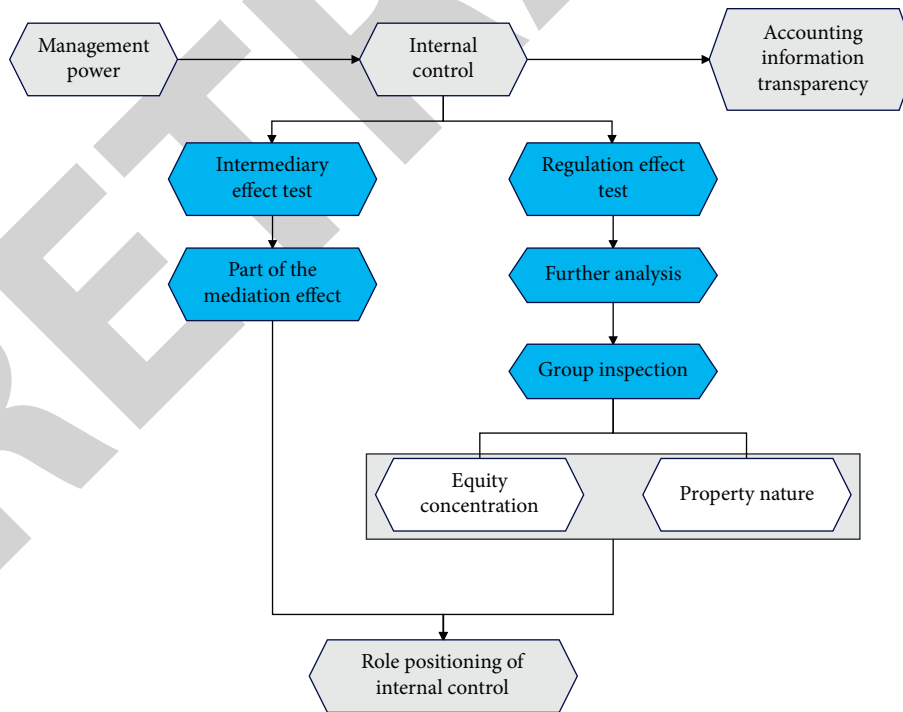


FIGURE 6: Logical structure diagram.

consideration of private interests, the management may manipulate the quality of accounting information by affecting the internal control of the enterprise or taking

advantage of the defects of internal control, so that the disclosure of accounting information has greater discretionary power. At the same time, internal control is a

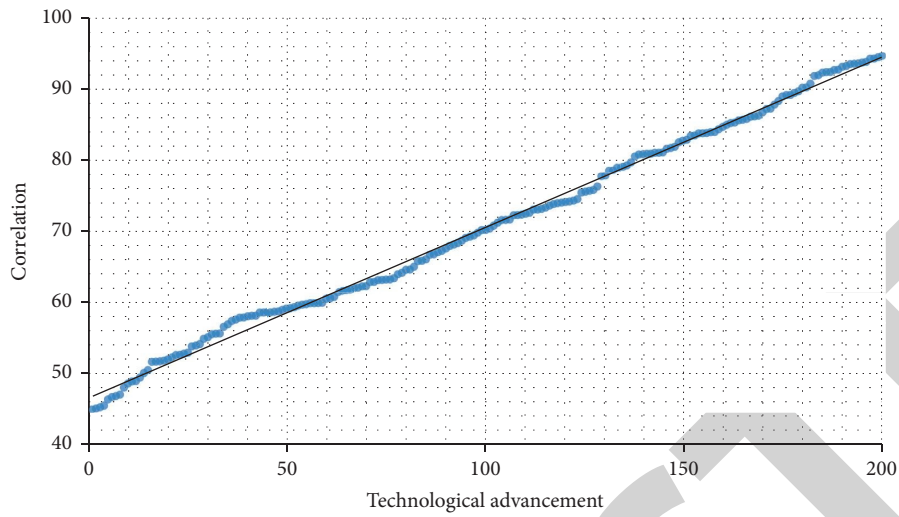


FIGURE 7: The relationship between intelligent accounting information management technology and corporate governance information transparency.

TABLE 1: Evaluation of the effect of intelligent accounting information management system.

Num	Evaluation
1	83.36
2	84.35
3	81.20
4	90.89
5	83.32
6	89.64
7	87.59
8	81.66
9	79.56
10	81.45
11	86.55
12	81.65
13	80.94
14	84.63
15	88.87
16	86.90
17	83.04
18	89.32
19	90.21
20	84.78
21	81.49
22	87.12
23	85.12
24	88.56
25	85.40
26	90.86
27	89.88
28	86.81
29	80.76
30	81.00
31	82.33
32	84.32
33	90.45
34	83.47
35	84.37
36	83.71

TABLE 1: Continued.

Num	Evaluation
37	84.95
38	87.67
39	87.08
40	83.22
41	84.71
42	90.22
43	83.61
44	86.56
45	82.62
46	79.69
47	85.86
48	79.16

necessary means to strengthen corporate governance, standardize internal processes, and supervise and restrain managers' behavior. A sound and complete internal control system can effectively restrain the self-interested behavior of the management and play an important role in ensuring the effective operation of various departments of the enterprise and improving the quality of accounting information. This paper assumes that the corresponding logical structure is shown in Figure 6.

On the basis of the above, the model proposed in this paper is verified, and the relationship between intelligent accounting information management technology and corporate governance information transparency is calculated. The statistical test results are shown in Figure 7.

Through the above regression analysis, we can see that there is a linear correlation between the advanced degree of intelligent accounting information management technology and the transparency of corporate governance information. On this basis, the effect of the model proposed in this paper is verified, and the statistical results are shown in Table 1.

From the above research, we can see that the intelligent accounting information management system proposed in this paper can effectively improve the corporate's accounting information management effect.

4. Conclusion

In the study of economics, the problem of investor protection has always been troubled by scholars. There are many factors that affect the level of investor protection. In addition to macro factors, there are not only the efficiency factors of the securities market itself but also corporate-level governance and management factors. Moreover, many factors affect each other, and it is difficult to solve all problems at one time. Combining these factors, improving the transparency of corporate accounting information has become a key link to achieve investor protection. This paper analyzes the information transparency in the process of corporate governance based on intelligent accounting information technology. Through regression analysis, we can see that there is a linear correlation between the advanced degree of intelligent accounting information management technology and the transparency of corporate governance information. At the same time, the intelligent accounting information

management system proposed in this paper can effectively improve the corporate's accounting information management effect.

Data Availability

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

Conflicts of Interest

The author declare no competing interests.

Acknowledgments

This study was sponsored by Chengdu Normal University.

References

- [1] J. A. Ojeniyi, E. O. Edward, and S. M. Abdulhamid, "Security risk analysis in online banking transactions: using diamond bank as a case study," *International Journal of Education and Management Engineering*, vol. 9, no. 2, pp. 1–14, 2019.
- [2] Н. ШмиГоль, О. Гальцова, Д. Крилов, А. Семенов, and К. ШаПошников, "Assessment of the prospects for restoring the financial security of the state," *Financial and credit activity problems of theory and practice*, vol. 5, no. 40, pp. 226–235, 2021.
- [3] N. Bhutta, J. Blair, L. Dettling, and K. Moore, "Covid-19, the cares act, and families' financial security," *National Tax Journal*, vol. 73, no. 3, pp. 645–672, 2020.
- [4] S. D. Mu, Y. X. Tian, and Y. Luo, "A study of the internet financial interest rate risk evaluation index system in cloud computing," *International Journal of Information and Computer Security*, vol. 11, no. 2, pp. 103–119, 2019.
- [5] N. Zachosova, "Innovative approach in the estimatology of financial institutions economic security: possibilities of use in management and regulatory activity within the means of provision of the state financial security," *Baltic Journal of Economic Studies*, vol. 5, no. 2, pp. 45–56, 2019.
- [6] M. H. Shirvani, A. M. Rahmani, and A. Sahafi, "An iterative mathematical decision model for cloud migration: a cost and security risk approach," *Software: Practice and Experience*, vol. 48, no. 3, pp. 449–485, 2018.
- [7] M. Tammelin, "The solo self-employed person and intrinsic financial security: does the promotion of self-employment