

Challenges of 5G Wireless Communication in Autonomous Vehicles

Lead Guest Editor: Amit Gupta

Guest Editors: Mustafa M Matalgah and Rakesh Shrestha





Challenges of 5G Wireless Communication in Autonomous Vehicles

Challenges of 5G Wireless Communication in Autonomous Vehicles

Lead Guest Editor: Amit Gupta

Guest Editors: Mustafa M Matalgah and Rakesh
Shrestha



Copyright © 2023 Hindawi Limited. All rights reserved.






This is a special issue published in “Mobile Information Systems.” 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

Alessandro Bazzi , Italy

Academic Editors

Mahdi Abbasi , Iran
Abdullah Alamoodi , Malaysia
Markos Anastassopoulos, United Kingdom
Marco Anisetti , Italy
Claudio Agostino Ardagna , Italy
Ashish Bagwari , India
Dr. Robin Singh Bhadoria , India
Nicola Bicocchi , Italy
Peter Brida , Slovakia
Puttamadappa C. , India
Carlos Calafate , Spain
Pengyun Chen, China
Yuh-Shyan Chen , Taiwan
Wenchi Cheng, China
Gabriele Civitarese , Italy
Massimo Condoluci , Sweden
Rajesh Kumar Dhanaraj, India
Rajesh Kumar Dhanaraj , India
Almudena Díaz Zayas , Spain
Filippo Gandino , Italy
Jorge Garcia Duque , Spain
Francesco Gringoli , Italy
Wei Jia, China
Adrian Kliks , Poland
Adarsh Kumar , India
Dongming Li, China
Juraj Machaj , Slovakia
Mirco Marchetti , Italy
Elio Masciari , Italy
Zahid Mehmood , Pakistan
Eduardo Mena , Spain
Massimo Merro , Italy
Aniello Minutolo , Italy
Jose F. Monserrat , Spain
Raul Montoliu , Spain
Mario Muñoz-Organero , Spain
Francesco Palmieri , Italy
Marco Picone , Italy
Alessandro Sebastian Podda , Italy
Maheswar Rajagopal, India
Amon Rapp , Italy
Filippo Sciarrone, Italy
Floriano Scioscia , Italy

Mohammed Shuaib , Malaysia
Michael Vassilakopoulos , Greece
Ding Xu , China
Laurence T. Yang , Canada
Kuo-Hui Yeh , Taiwan

Contents

Retracted: Analysis of the Effect of Video-Guided Dance Creation for Young Children

Mobile Information Systems

Retraction (1 page), Article ID 9876742, Volume 2023 (2023)

Retracted: Construction and Management of Intelligent Campus Based on Student Privacy Protection under the Background of Artificial Intelligence and Internet of Things

Mobile Information Systems

Retraction (1 page), Article ID 9852380, Volume 2023 (2023)

Retracted: Assessment and Test-Case Study of Wi-Fi Security through the Wardriving Technique

Mobile Information Systems

Retraction (1 page), Article ID 9863675, Volume 2023 (2023)

Retracted: Analysis of Syntactic Complexity and Semantic Coherence of Academic English Writing Based on Particle Swarm Optimization

Mobile Information Systems

Retraction (1 page), Article ID 9861530, Volume 2023 (2023)

Retracted: Coordinated Development of China's Regional Economy and Ethnic Diversity under the Background of Big Data and the Internet of Things

Mobile Information Systems

Retraction (1 page), Article ID 9854592, Volume 2023 (2023)

Retracted: Construction of College Chinese Writing Practice Teaching Platform under the Background of Information Technology

Mobile Information Systems

Retraction (1 page), Article ID 9853930, Volume 2023 (2023)

Retracted: SURF Algorithm-Based Data Aggregation Method and Digital Sharing Economy

Mobile Information Systems

Retraction (1 page), Article ID 9852176, Volume 2023 (2023)

Retracted: A Study of Industrial Convergence in the Context of Digital Economy Based on Scientific Computing Visualization

Mobile Information Systems

Retraction (1 page), Article ID 9848212, Volume 2023 (2023)

Retracted: Application Model Construction of Traditional Cultural Elements in Illustration Design under Artificial Intelligence Background

Mobile Information Systems

Retraction (1 page), Article ID 9847068, Volume 2023 (2023)

Retracted: The Protection and Restoration of Ancient Buildings in Guanzhong Traditional Villages Based on the Improved Priority Algorithm

Mobile Information Systems

Retraction (1 page), Article ID 9843081, Volume 2023 (2023)

Retracted: Piano Intelligent Teaching Evaluation with IoT and Multimedia Technology

Mobile Information Systems

Retraction (1 page), Article ID 9834547, Volume 2023 (2023)

Retracted: Online Simulation Quality Assessment of Illustration Patterns Based on Digital Art Design in Neural Network Perspective

Mobile Information Systems

Retraction (1 page), Article ID 9828259, Volume 2023 (2023)

Retracted: Application of Internet of Things Architecture in Intelligent Classroom Teaching Analysis in Colleges and Universities

Mobile Information Systems

Retraction (1 page), Article ID 9825071, Volume 2023 (2023)

Retracted: Research on the Significance of Big Data and Artificial Intelligence Technology to Enterprise Business Management

Mobile Information Systems

Retraction (1 page), Article ID 9817971, Volume 2023 (2023)

Retracted: Innovation and Digital Construction of Cultural Tourism Industry under the Background of Big Data and Internet of Things

Mobile Information Systems

Retraction (1 page), Article ID 9816013, Volume 2023 (2023)

Retracted: Construction of Risk Control Decision-Making Model Platform for Transportation Hub Projects under the Background of Message Technique

Mobile Information Systems

Retraction (1 page), Article ID 9809785, Volume 2023 (2023)

Retracted: Design and Management of Microteaching Mode of Innovation and Entrepreneurship Education in Colleges and Universities Driven by Big Data

Mobile Information Systems

Retraction (1 page), Article ID 9803041, Volume 2023 (2023)

Retracted: Design of Hybrid Teaching System for Aerobic Exercise Class of Recreational Sports Major

Mobile Information Systems

Retraction (1 page), Article ID 9797615, Volume 2023 (2023)

Retracted: Coordinated Development of Smart City and Regional Industrial Economy under the Background of Internet of Things

Mobile Information Systems

Retraction (1 page), Article ID 9760903, Volume 2023 (2023)

Retracted: Space Modeling Design Art of Suspense Movies Based on Machine Vision

Mobile Information Systems

Retraction (1 page), Article ID 9760571, Volume 2023 (2023)

Contents

Retracted: Soccer Player Video Target Tracking Based on Deep Learning

Mobile Information Systems

Retraction (1 page), Article ID 9896879, Volume 2023 (2023)

Retracted: English Writing Feedback Based on Online Automatic Evaluation in the Era of Big Data

Mobile Information Systems

Retraction (1 page), Article ID 9895408, Volume 2023 (2023)

Retracted: Bayesian Network Structure Learning and Application

Mobile Information Systems

Retraction (1 page), Article ID 9894831, Volume 2023 (2023)

Retracted: The Macroreform of the Electronics Manufacturing Industry under the Industry 4.0 Wave Based on Financial Performance Indicators

Mobile Information Systems

Retraction (1 page), Article ID 9893405, Volume 2023 (2023)

Retracted: Key Technologies of Digital Protection of Historical and Cultural Heritage Based on Virtual Reality Technology

Mobile Information Systems

Retraction (1 page), Article ID 9878716, Volume 2023 (2023)

Retracted: Analysis of the Coupled and Coordinated Relationship between Emission of Carbon: International Growth of Economy-Conservation of the Environment in China

Mobile Information Systems

Retraction (1 page), Article ID 9876950, Volume 2023 (2023)

Retracted: Precision Marketing Strategy for Ecotourism Based on Data Mining and User Images

Mobile Information Systems

Retraction (1 page), Article ID 9871606, Volume 2023 (2023)

Retracted: Analysis on Organizational Structure System Model of China's Sports Management System Based on KNN Algorithm

Mobile Information Systems

Retraction (1 page), Article ID 9869602, Volume 2023 (2023)

Retracted: Quality Evaluation Method of College Sports Long Jump Training Course Based on Genetic Algorithm

Mobile Information Systems

Retraction (1 page), Article ID 9869376, Volume 2023 (2023)

Retracted: Library Document Resource Construction and Data Sharing Based on Semantic Web Technology

Mobile Information Systems

Retraction (1 page), Article ID 9864940, Volume 2023 (2023)

Retracted: Infrastructure Smart Service System Based on Big Data Information System

Mobile Information Systems

Retraction (1 page), Article ID 9879217, Volume 2022 (2022)

Retracted: Design of Chinese Opera Cultural Platform Based on Digital Twins and Research on International Cultural Communication Strategies

Mobile Information Systems


Retraction (1 page), Article ID 9802454, Volume 2022 (2022)

[Retracted] Design of Chinese Opera Cultural Platform Based on Digital Twins and Research on International Cultural Communication Strategies

Li Ma 


Research Article (12 pages), Article ID 6996377, Volume 2022 (2022)

[Retracted] Design of Hybrid Teaching System for Aerobic Exercise Class of Recreational Sports Major

Sha Yang  and Xiulei Mao


Research Article (12 pages), Article ID 1491480, Volume 2022 (2022)

[Retracted] Analysis on Organizational Structure System Model of China's Sports Management System Based on KNN Algorithm

Jie Ren and Congxin Du 


Research Article (10 pages), Article ID 7048312, Volume 2022 (2022)

[Retracted] Coordinated Development of Smart City and Regional Industrial Economy under the Background of Internet of Things

Liping Chen 


Research Article (8 pages), Article ID 6986090, Volume 2022 (2022)

[Retracted] Innovation and Digital Construction of Cultural Tourism Industry under the Background of Big Data and Internet of Things

Bo Liu 


Research Article (8 pages), Article ID 9019536, Volume 2022 (2022)

[Retracted] Infrastructure Smart Service System Based on Big Data Information System

Wang Dou 

Research Article (12 pages), Article ID 9261023, Volume 2022 (2022)


[Retracted] Construction and Management of Intelligent Campus Based on Student Privacy Protection under the Background of Artificial Intelligence and Internet of Things

Pujin Yi  and Zhongwu Li

Research Article (6 pages), Article ID 2154577, Volume 2022 (2022)


Contents

[Retracted] Coordinated Development of China's Regional Economy and Ethnic Diversity under the Background of Big Data and the Internet of Things

Hongliang Miao 


Research Article (8 pages), Article ID 6424505, Volume 2022 (2022)

[Retracted] Soccer Player Video Target Tracking Based on Deep Learning

Bo Zheng 

Research Article (6 pages), Article ID 8090871, Volume 2022 (2022)

[Retracted] Research on the Significance of Big Data and Artificial Intelligence Technology to Enterprise Business Management

Haibo Li 


Research Article (10 pages), Article ID 7639965, Volume 2022 (2022)

[Retracted] Analysis of Syntactic Complexity and Semantic Coherence of Academic English Writing Based on Particle Swarm Optimization

Lei Li 


Research Article (9 pages), Article ID 9917832, Volume 2022 (2022)

[Retracted] SURF Algorithm-Based Data Aggregation Method and Digital Sharing Economy

Yeqing Chen , Mengze Zhang, Baeki Hyng, and Rui Wang





Research Article (10 pages), Article ID 1513129, Volume 2022 (2022)

[Retracted] Piano Intelligent Teaching Evaluation with IoT and Multimedia Technology

Dongkui Wang and Zuolian Bai 


Research Article (10 pages), Article ID 7636458, Volume 2022 (2022)

[Retracted] Assessment and Test-case Study of Wi-Fi Security through the Wardriving Technique

Victor Ojong Etta , Arif Sari, Agbotiname Lucky Imoize , Piyush Kumar Shukla , and Musah Alhassan 


Research Article (21 pages), Article ID 7936236, Volume 2022 (2022)

[Retracted] Precision Marketing Strategy for Ecotourism Based on Data Mining and User Images

Xi Chen, Qinjin Li , Fuxia Zou, Dan Wang, Tao Li, and Mengyao Hu


Research Article (8 pages), Article ID 1104633, Volume 2022 (2022)

[Retracted] Construction of Risk Control Decision-Making Model Platform for Transportation Hub Projects under the Background of Message Technique

Ping Zhong, Hang Yin , and Yuanfu Li


Research Article (11 pages), Article ID 1199289, Volume 2022 (2022)

[Retracted] Construction of College Chinese Writing Practice Teaching Platform under the Background of Information Technology

Jingli Wu 


Research Article (9 pages), Article ID 9038215, Volume 2022 (2022)

[Retracted] Bayesian Network Structure Learning and Application

Liwei Zhang , Dayou Liu, Zheng Wang, and Xinlu Wang

Research Article (9 pages), Article ID 7642339, Volume 2022 (2022)

[Retracted] Application of Internet of Things Architecture in Intelligent Classroom Teaching Analysis in Colleges and Universities

Hongna Du 


Research Article (7 pages), Article ID 4831937, Volume 2022 (2022)

[Retracted] Design and Management of Microteaching Mode of Innovation and Entrepreneurship Education in Colleges and Universities Driven by Big Data

Huirong Zhu  and Qin Wang


Research Article (10 pages), Article ID 4689950, Volume 2022 (2022)

[Retracted] A Study of Industrial Convergence in the Context of Digital Economy Based on Scientific Computing Visualization

Shiyuan Zhou , Xiaoqin Yang, and Zhixiong Liao


Research Article (12 pages), Article ID 4025875, Volume 2022 (2022)

[Retracted] The Protection and Restoration of Ancient Buildings in Guanzhong Traditional Villages Based on the Improved Priority Algorithm

Chang Li  and Yiyuan Zhao


Research Article (8 pages), Article ID 8203590, Volume 2022 (2022)

[Retracted] Online Simulation Quality Assessment of Illustration Patterns Based on Digital Art Design in Neural Network Perspective

Lin Yang 

Research Article (9 pages), Article ID 7152454, Volume 2022 (2022)

[Retracted] Key Technologies of Digital Protection of Historical and Cultural Heritage Based on Virtual Reality Technology

Weiguo Zhang 


Research Article (8 pages), Article ID 1598160, Volume 2022 (2022)

[Retracted] Quality Evaluation Method of College Sports Long Jump Training Course Based on Genetic Algorithm

Bing Han , Zhen Wang , and Zhilong Zhao 

Research Article (10 pages), Article ID 7905389, Volume 2022 (2022)


[Retracted] Library Document Resource Construction and Data Sharing Based on Semantic Web Technology

Xinyuan Fan 

Research Article (11 pages), Article ID 2168655, Volume 2022 (2022)


Contents

[Retracted] Analysis of the Coupled and Coordinated Relationship between Emission of Carbon: International Growth of Economy-Conservation of the Environment in China

Zhenfeng Lan 


Research Article (11 pages), Article ID 9373389, Volume 2022 (2022)

[Retracted] Space Modeling Design Art of Suspense Movies Based on Machine Vision

Zhicheng Zuo 


Research Article (9 pages), Article ID 8149182, Volume 2022 (2022)

[Retracted] Analysis of the Effect of Video-Guided Dance Creation for Young Children

Yanan Qin , Tao Huang, and Guanzhen Tang


Research Article (8 pages), Article ID 1110698, Volume 2022 (2022)

[Retracted] Application Model Construction of Traditional Cultural Elements in Illustration Design under Artificial Intelligence Background

Lei Shi 


Research Article (9 pages), Article ID 7412066, Volume 2022 (2022)

[Retracted] English Writing Feedback Based on Online Automatic Evaluation in the Era of Big Data

Jing Li 

Research Article (9 pages), Article ID 9884273, Volume 2022 (2022)

[Retracted] The Macroreform of the Electronics Manufacturing Industry under the Industry 4.0 Wave Based on Financial Performance Indicators

Yixian Wen 

Research Article (7 pages), Article ID 6436112, Volume 2022 (2022)

Retraction

Retracted: Analysis of the Effect of Video-Guided Dance Creation for Young Children

Mobile Information Systems

Received 26 September 2023; Accepted 26 September 2023; Published 27 September 2023

Copyright © 2023 Mobile Information Systems. 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. Qin, T. Huang, and G. Tang, "Analysis of the Effect of Video-Guided Dance Creation for Young Children," *Mobile Information Systems*, vol. 2022, Article ID 1110698, 8 pages, 2022.

Retraction

Retracted: Construction and Management of Intelligent Campus Based on Student Privacy Protection under the Background of Artificial Intelligence and Internet of Things

Mobile Information Systems

Received 26 September 2023; Accepted 26 September 2023; Published 27 September 2023

Copyright © 2023 Mobile Information Systems. 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] P. Yi and Z. Li, "Construction and Management of Intelligent Campus Based on Student Privacy Protection under the Background of Artificial Intelligence and Internet of Things," *Mobile Information Systems*, vol. 2022, Article ID 2154577, 6 pages, 2022.

Retraction

Retracted: Assessment and Test-Case Study of Wi-Fi Security through the Wardriving Technique

Mobile Information Systems

Received 8 August 2023; Accepted 8 August 2023; Published 9 August 2023

Copyright © 2023 Mobile Information Systems. 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] V. O. Etta, A. Sari, A. L. Imoize, P. K. Shukla, and M. Alhassan, "Assessment and Test-Case Study of Wi-Fi Security through the Wardriving Technique," *Mobile Information Systems*, vol. 2022, Article ID 7936236, 21 pages, 2022.

Retraction

Retracted: Analysis of Syntactic Complexity and Semantic Coherence of Academic English Writing Based on Particle Swarm Optimization

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Li, "Analysis of Syntactic Complexity and Semantic Coherence of Academic English Writing Based on Particle Swarm Optimization," *Mobile Information Systems*, vol. 2022, Article ID 9917832, 9 pages, 2022.

Retraction

Retracted: Coordinated Development of China's Regional Economy and Ethnic Diversity under the Background of Big Data and the Internet of Things

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Miao, "Coordinated Development of China's Regional Economy and Ethnic Diversity under the Background of Big Data and the Internet of Things," *Mobile Information Systems*, vol. 2022, Article ID 6424505, 8 pages, 2022.

Retraction

Retracted: Construction of College Chinese Writing Practice Teaching Platform under the Background of Information Technology

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Wu, "Construction of College Chinese Writing Practice Teaching Platform under the Background of Information Technology," *Mobile Information Systems*, vol. 2022, Article ID 9038215, 9 pages, 2022.

Retraction

Retracted: SURF Algorithm-Based Data Aggregation Method and Digital Sharing Economy

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Chen, M. Zhang, B. Hyng, and R. Wang, "SURF Algorithm-Based Data Aggregation Method and Digital Sharing Economy," *Mobile Information Systems*, vol. 2022, Article ID 1513129, 10 pages, 2022.

Retraction

Retracted: A Study of Industrial Convergence in the Context of Digital Economy Based on Scientific Computing Visualization

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] S. Zhou, X. Yang, and Z. Liao, "A Study of Industrial Convergence in the Context of Digital Economy Based on Scientific Computing Visualization," *Mobile Information Systems*, vol. 2022, Article ID 4025875, 12 pages, 2022.

Retraction

Retracted: Application Model Construction of Traditional Cultural Elements in Illustration Design under Artificial Intelligence Background

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Shi, "Application Model Construction of Traditional Cultural Elements in Illustration Design under Artificial Intelligence Background," *Mobile Information Systems*, vol. 2022, Article ID 7412066, 9 pages, 2022.

Retraction

Retracted: The Protection and Restoration of Ancient Buildings in Guanzhong Traditional Villages Based on the Improved Priority Algorithm

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] C. Li and Y. Zhao, "The Protection and Restoration of Ancient Buildings in Guanzhong Traditional Villages Based on the Improved Priority Algorithm," *Mobile Information Systems*, vol. 2022, Article ID 8203590, 8 pages, 2022.

Retraction

Retracted: Piano Intelligent Teaching Evaluation with IoT and Multimedia Technology

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] D. Wang and Z. Bai, "Piano Intelligent Teaching Evaluation with IoT and Multimedia Technology," *Mobile Information Systems*, vol. 2022, Article ID 7636458, 10 pages, 2022.

Retraction

Retracted: Online Simulation Quality Assessment of Illustration Patterns Based on Digital Art Design in Neural Network Perspective

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Yang, "Online Simulation Quality Assessment of Illustration Patterns Based on Digital Art Design in Neural Network Perspective," *Mobile Information Systems*, vol. 2022, Article ID 7152454, 9 pages, 2022.

Retraction

Retracted: Application of Internet of Things Architecture in Intelligent Classroom Teaching Analysis in Colleges and Universities

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Du, "Application of Internet of Things Architecture in Intelligent Classroom Teaching Analysis in Colleges and Universities," *Mobile Information Systems*, vol. 2022, Article ID 4831937, 7 pages, 2022.

Retraction

Retracted: Research on the Significance of Big Data and Artificial Intelligence Technology to Enterprise Business Management

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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, "Research on the Significance of Big Data and Artificial Intelligence Technology to Enterprise Business Management," *Mobile Information Systems*, vol. 2022, Article ID 7639965, 10 pages, 2022.

Retraction

Retracted: Innovation and Digital Construction of Cultural Tourism Industry under the Background of Big Data and Internet of Things

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] B. Liu, "Innovation and Digital Construction of Cultural Tourism Industry under the Background of Big Data and Internet of Things," *Mobile Information Systems*, vol. 2022, Article ID 9019536, 8 pages, 2022.

Retraction

Retracted: Construction of Risk Control Decision-Making Model Platform for Transportation Hub Projects under the Background of Message Technique

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] P. Zhong, H. Yin, and Y. Li, "Construction of Risk Control Decision-Making Model Platform for Transportation Hub Projects under the Background of Message Technique," *Mobile Information Systems*, vol. 2022, Article ID 1199289, 11 pages, 2022.

Retraction

Retracted: Design and Management of Microteaching Mode of Innovation and Entrepreneurship Education in Colleges and Universities Driven by Big Data

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Zhu and Q. Wang, "Design and Management of Microteaching Mode of Innovation and Entrepreneurship Education in Colleges and Universities Driven by Big Data," *Mobile Information Systems*, vol. 2022, Article ID 4689950, 10 pages, 2022.

Retraction

Retracted: Design of Hybrid Teaching System for Aerobic Exercise Class of Recreational Sports Major

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] S. Yang and X. Mao, "Design of Hybrid Teaching System for Aerobic Exercise Class of Recreational Sports Major," *Mobile Information Systems*, vol. 2022, Article ID 1491480, 12 pages, 2022.

Retraction

Retracted: Coordinated Development of Smart City and Regional Industrial Economy under the Background of Internet of Things

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Chen, "Coordinated Development of Smart City and Regional Industrial Economy under the Background of Internet of Things," *Mobile Information Systems*, vol. 2022, Article ID 6986090, 8 pages, 2022.

Retraction

Retracted: Space Modeling Design Art of Suspense Movies Based on Machine Vision

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Zuo, "Space Modeling Design Art of Suspense Movies Based on Machine Vision," *Mobile Information Systems*, vol. 2022, Article ID 8149182, 9 pages, 2022.

Retraction

Retracted: Soccer Player Video Target Tracking Based on Deep Learning

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] B. Zheng, "Soccer Player Video Target Tracking Based on Deep Learning," *Mobile Information Systems*, vol. 2022, Article ID 8090871, 6 pages, 2022.

Retraction

Retracted: English Writing Feedback Based on Online Automatic Evaluation in the Era of Big Data

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Li, "English Writing Feedback Based on Online Automatic Evaluation in the Era of Big Data," *Mobile Information Systems*, vol. 2022, no. 1, Article ID 9884273, 9 pages, 2022.

Retraction

Retracted: Bayesian Network Structure Learning and Application

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Zhang, D. Liu, Z. Wang, and X. Wang, "Bayesian Network Structure Learning and Application," *Mobile Information Systems*, vol. 2022, Article ID 7642339, 9 pages, 2022.

Retraction

Retracted: The Macroreform of the Electronics Manufacturing Industry under the Industry 4.0 Wave Based on Financial Performance Indicators

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Wen, "The Macroreform of the Electronics Manufacturing Industry under the Industry 4.0 Wave Based on Financial Performance Indicators," *Mobile Information Systems*, vol. 2022, Article ID 6436112, 7 pages, 2022.

Retraction

Retracted: Key Technologies of Digital Protection of Historical and Cultural Heritage Based on Virtual Reality Technology

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] W. Zhang, "Key Technologies of Digital Protection of Historical and Cultural Heritage Based on Virtual Reality Technology," *Mobile Information Systems*, vol. 2022, Article ID 1598160, 8 pages, 2022.

Retraction

Retracted: Analysis of the Coupled and Coordinated Relationship between Emission of Carbon: International Growth of Economy-Conservation of the Environment in China

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Lan, "Analysis of the Coupled and Coordinated Relationship between Emission of Carbon: International Growth of Economy-Conservation of the Environment in China," *Mobile Information Systems*, vol. 2022, Article ID 9373389, 11 pages, 2022.

Retraction

Retracted: Precision Marketing Strategy for Ecotourism Based on Data Mining and User Images

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] X. Chen, Q. Li, F. Zou, D. Wang, T. Li, and M. Hu, "Precision Marketing Strategy for Ecotourism Based on Data Mining and User Images," *Mobile Information Systems*, vol. 2022, Article ID 1104633, 8 pages, 2022.

Retraction

Retracted: Analysis on Organizational Structure System Model of China's Sports Management System Based on KNN Algorithm

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Ren and C. Du, "Analysis on Organizational Structure System Model of China's Sports Management System Based on KNN Algorithm," *Mobile Information Systems*, vol. 2022, Article ID 7048312, 10 pages, 2022.

Retraction

Retracted: Quality Evaluation Method of College Sports Long Jump Training Course Based on Genetic Algorithm

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] B. Han, Z. Wang, and Z. Zhao, "Quality Evaluation Method of College Sports Long Jump Training Course Based on Genetic Algorithm," *Mobile Information Systems*, vol. 2022, Article ID 7905389, 10 pages, 2022.

Retraction

Retracted: Library Document Resource Construction and Data Sharing Based on Semantic Web Technology

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] X. Fan, "Library Document Resource Construction and Data Sharing Based on Semantic Web Technology," *Mobile Information Systems*, vol. 2022, Article ID 2168655, 11 pages, 2022.

Retraction

Retracted: Infrastructure Smart Service System Based on Big Data Information System

Mobile Information Systems

Received 7 November 2022; Accepted 7 November 2022; Published 22 November 2022

Copyright © 2022 Mobile Information Systems. 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.

Mobile Information Systems has retracted the article titled “Infrastructure Smart Service System Based on Big Data Information System” [1] due to concerns that the peer review process has been compromised.

Following an investigation conducted by the Hindawi Research Integrity team [2], significant concerns were identified with the peer reviewers assigned to this article; the investigation has concluded that the peer review process was compromised. We therefore can no longer trust the peer review process, and the article is being retracted with the agreement of the Chief Editor.

References

- [1] D. Wang, “Infrastructure Smart Service System Based on Big Data Information System,” *Mobile Information Systems*, vol. 2022, Article ID 9261023, 12 pages, 2022.
- [2] L. Ferguson, “Advancing Research Integrity Collaboratively and with Vigour,” 2022, <https://www.hindawi.com/post/advancing-research-integrity-collaboratively-and-vigour/>.

Retraction

Retracted: Design of Chinese Opera Cultural Platform Based on Digital Twins and Research on International Cultural Communication Strategies

Mobile Information Systems

Received 8 November 2022; Accepted 8 November 2022; Published 18 November 2022

Copyright © 2022 Mobile Information Systems. 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.

Mobile Information Systems has retracted the article titled “Design of Chinese Opera Cultural Platform Based on Digital Twins and Research on International Cultural Communication Strategies” [1] due to concerns that the peer review process has been compromised.

Following an investigation conducted by the Hindawi Research Integrity team [2], significant concerns were identified with the peer reviewers assigned to this article; the investigation has concluded that the peer review process was compromised. We therefore can no longer trust the peer review process, and the article is being retracted with the agreement of the Chief Editor.

References

- [1] L. Ma, “Design of Chinese Opera Cultural Platform Based on Digital Twins and Research on International Cultural Communication Strategies,” *Mobile Information Systems*, vol. 2022, Article ID 6996377, 12 pages, 2022.
- [2] <https://www.hindawi.com/post/advancing-research-integrity-collaboratively-and-vigour/>.

Retraction

Retracted: Design of Chinese Opera Cultural Platform Based on Digital Twins and Research on International Cultural Communication Strategies

Mobile Information Systems

Received 8 November 2022; Accepted 8 November 2022; Published 18 November 2022

Copyright © 2022 Mobile Information Systems. 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.

Mobile Information Systems has retracted the article titled “Design of Chinese Opera Cultural Platform Based on Digital Twins and Research on International Cultural Communication Strategies” [1] due to concerns that the peer review process has been compromised.

Following an investigation conducted by the Hindawi Research Integrity team [2], significant concerns were identified with the peer reviewers assigned to this article; the investigation has concluded that the peer review process was compromised. We therefore can no longer trust the peer review process, and the article is being retracted with the agreement of the Chief Editor.

References

- [1] L. Ma, “Design of Chinese Opera Cultural Platform Based on Digital Twins and Research on International Cultural Communication Strategies,” *Mobile Information Systems*, vol. 2022, Article ID 6996377, 12 pages, 2022.
- [2] <https://www.hindawi.com/post/advancing-research-integrity-collaboratively-and-vigour/>.

Research Article

Design of Chinese Opera Cultural Platform Based on Digital Twins and Research on International Cultural Communication Strategies

Li Ma 

School of Music and Dance, Yulin Normal University, Yulin 537000, Guangxi Zhuang Autonomous Region, China

Correspondence should be addressed to Li Ma; mary1984262022@163.com

Received 12 May 2022; Revised 22 June 2022; Accepted 7 July 2022; Published 12 August 2022

Academic Editor: Amit Gupta

Copyright © 2022 Li Ma. 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 important part of a country's diplomatic strategy, international cultural communication is increasingly valued by countries. But the traditional way of communication has been unable to keep up with the pace of the times. Digital twin technology can realize virtual reality, which can be applied to the design and dissemination of opera cultural platforms. The influence of a country's culture not only depends on whether its content has unique charm but also depends on whether it has advanced means of communication and strong communication ability. The purpose of this paper is to study how to design an opera cultural platform based on digital twins. This paper proposes a three-dimensional transformation algorithm based on digital twin, which can play a good role in the design of the opera culture platform. The experimental results in this paper are shown in Table 1. In 2016, the economic benefits brought by international cultural communication to China were 35.889 billion yuan. It increased by 3.735 billion yuan year-on-year, with a growth rate of 10.4%. By 2019, the economic benefits brought by international cultural communication to China were 50.730 billion yuan, with an increase of 49.66% over the previous year and a growth rate of 9.7%. It can be seen that, through continuous external communication, this aspect shows the cultural strength of the country and obtains an excellent international reputation and social benefits. On the other hand, it reaped considerable economic benefits. Therefore, it is very necessary to study the strategies of international cultural communication.

1. Introduction

In recent years, with the improvement of China's comprehensive national strength and international influence, Chinese culture has received more and more attention, and the scope of dissemination has also expanded. But, at the same time, the spread of Chinese culture in the world is also facing various challenges. In the context of globalization, how to enhance the soft power of Chinese culture and expand the influence of Chinese culture is the focus of today's Chinese culture development strategy. In today's world, cultural competition and dissemination have become a trend. That is to say, cultural communication can promote the exchange and integration of different cultures and promote the formation and development of multiculturalism.

In the previous forms of dissemination of opera culture, there has been no great innovation in dissemination methods

except for traditional information push channels such as websites and WeChat platforms. The public's understanding of opera performances is also obtained through specific information links related to opera. The singleness and limitation of the dissemination method limit the dissemination of opera culture and also hinder the consumption of mass entertainment. The way of dissemination of opera culture should change with the changes of the times, in line with the public's aesthetic orientation in terms of storyline and performance form, and be close to life. It is necessary to focus on the current situation of the development of opera, from the perspective of thinking and cognition, and focus on the way of opera transmission. Under the premise of using public media art, it is necessary to create interactive works that allow the public to participate in interaction and emotional exchange.

The innovations of this paper are (1) it introduces the related theoretical knowledge of digital twin technology,

opera culture, and international cultural dissemination. It also proposes a three-dimensional transformation algorithm based on the digital twin and analyzes how the digital twin plays a role in the design of the opera culture platform. (2) It conducts research on traditional cultural communication methods as well as cultural communication methods based on digital twins. It is learned through experiments that cultural dissemination based on digital twins is more conducive to arousing people's interest and promoting international cultural exchanges.

2. Related Work

The development of the "global village" promotes cultural exchange, dissemination, and integration between countries. Chinese culture is extensive and profound, and it is inseparable from the continuous exchanges between China and other countries and national cultures. This is an important driving force for China's cultural development. With the increasing influence of cultural communication in recent years, people have begun to pay attention to the strategy of international communication. Cui C found that the protection and dissemination of China's intangible cultural heritage had developed from a single industry activity to a social effort involving a wide range of fields. How to raise the awareness of the younger generation has become an important issue for the protection and dissemination of intangible cultural heritage. The scholar recognized the importance of cultural communication, but did not explain how it carried out cultural communication [1]. Hogue et al. aimed to demonstrate the use of media through installations in media digital art. Especially among the young class, it can lead to reflection and awareness of the risks and problems caused by the media digital art. The scholar believed that digital media art is at risk. But what is the risk, he did not explain [2]. Barrille et al. found that bronzes, due to their excellent manufacture, represent important sculptural masterpieces in the world. He introduced the realization of the 3D model of the two sculptures. The results he achieved demonstrate the effectiveness of 3D printing to create digital products and reproductions. But the scholar did not describe the specific experimental process [3]. Zhang et al. found that in order to realize smart manufacturing, the country has formulated new strategies, and the number of new factories in developed and developing countries is increasing. He proposed a digital twin-based approach for rapid personalized design of insulating glass production lines. The scholar did not explain why he chose digital twin technology [4]. Zhuang et al. believed that digital twin technology is the core and key technology for realizing cyber-physical systems. Product digital twin is one of the applications of digital twin technology in the product development process. He conducted research on the future development trends of product digital twins. The scholar mentioned that he wanted to conduct research on digital twins, but did not describe the process or results of the research [5]. The purpose of Kuznetsova et al.'s discovery scientific work was to use production-based digital twin modeling to assess the level of information security of automated enterprise systems. He

worked on solving the problem of building digital twins of enterprise automation systems. He proposed the use of digital twin technology to evaluate information from automated systems. However, the scholar did not draw corresponding conclusions [6].

3. 3D Transformation Algorithm Based on Digital Twin

3.1. The Dissemination of Opera Culture. The cross-cultural dissemination of Chinese opera in the first half of the 20th century showed a very good trend. Among them, there are many outstanding Chinese scholars and performers of Chinese opera who are patriotic and proficient in Chinese opera [7]. It is also because during this period, the continuous wars, although they brought endless suffering to the Chinese people, also opened the door to China. This gives the West the opportunity to come to China, and it also facilitates the opportunity for the Chinese to go abroad. Chinese opera has finally been able to show its unique charm on the Western stage. Opera generally refers to Chinese opera. Chinese opera is mainly composed of three different art forms: folk song and dance, rap, and burlesque. It originated from primitive singing and dancing and is a comprehensive stage art style with a long history. During this period, the cross-cultural communication of Chinese opera was mainly based on text communication [8]. Opera culture is shown in Figure 1:

As shown in Figure 1, later, the cross-cultural dissemination of Chinese opera was mainly performed by large groups in the form of cross-border performance visits. With the founding of New China, the government was able to plan transnational visit routes while coordinating actors. This makes the cross-cultural dissemination of opera in addition to the dissemination of Chinese culture, adding more diplomatic color [9]. Chinese opera, Greek tragedy and comedy, and Indian Sanskrit opera are known as the three ancient drama cultures in the world. After a long period of development and evolution, it has gradually formed the Baihuayuan of Chinese Opera with the five major opera genres as "Peking Opera, Yue Opera, Huangmei Opera, Pingju Opera, and Henan Opera." As a part of the new China's diplomatic construction, Chinese opera has played an ice-breaking role in eliminating estrangement in the process of establishing or restoring diplomatic relations with many countries. The cross-cultural dissemination of Chinese opera has experienced a process from single type to diversity.

3.2. Feasibility of Combining Digital Twin with Chinese Opera Cultural Platform. In recent years, with the development of information technology, a new round of industrial transformation and technological revolution has emerged. It promotes intelligent manufacturing to become an inevitable trend in the development of the manufacturing industry [10]. In the practice of intelligent manufacturing, digital twin has been widely concerned as the best solution to realize the fusion and interaction of physical space and information space. However, digital twin technology is still in the



FIGURE 1: Opera culture.

theoretical research stage. The research on the application of digital twin is also in the stage of exploration and practice [11]. Digital twin is a simulation process that integrates multidisciplinary, multiphysics, multiscale, and multi-probability by making full use of physical model, sensor update, operation history, and other data. It completes the mapping in the virtual space, thus reflecting the whole life cycle process of the corresponding physical equipment. It is shown in Figure 2:

Figure 2 shows the industrial digital twin focuses on the simulation of complex mechanical entities in the physical world in the design, manufacture, and use stages. It seeks to establish an accurate mapping of the physical world in the digital world through a large amount of sensor data and material physical property data. The industrial digital twin uses artificial intelligence technology as a means, combined with spatial geographic information technology, and independently developed a one-stop digital twin service for the entire industry chain. It also empowers data through the comprehensive use of big data and Internet of Things technology and drives the penetration of “intelligence +” in various segments. It has the following properties:

Multiphysics: the product digital twin needs to describe the geometric characteristics of the corresponding physical product, various physical characteristics, and environmental information in the use and service phases of the product. The design of the opera culture platform requires a digital mapping model of physical products based on physical characteristics [12].

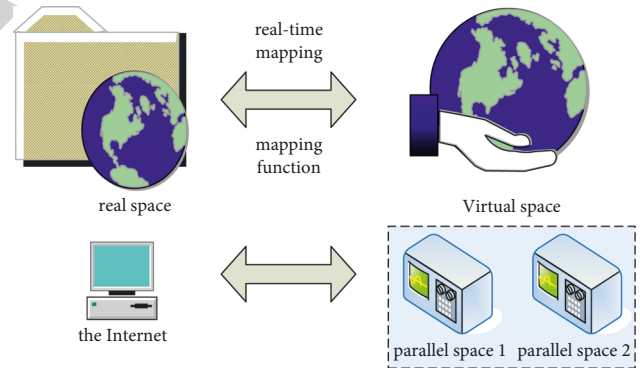


FIGURE 2: Principles of industrial digital twin technology.

Dynamic: during the whole life cycle of a real device, the information of opera culture in the real device will be reflected in the virtual digital twin device. The virtual digital twin device can also monitor the dissemination process and usage of opera culture in real time [13].

Through these analyses, it believes that it is feasible to combine the traditional opera culture platform with the industrial digital twin. It can focus on the real-time mapping, simulation, and remote control of the digital twin in the stage of opera cultural performance. It can improve the intelligence of opera culture in the direction of intelligence, dissemination, and dynamic automatic optimization of planning and deployment [14].

3.3. 3D Transformation Algorithms. 3D graphics transformation is the process of transforming the original 3D graphics into a new 3D graphics after translation, scaling, and rotation. A spatial position is corresponded by a point in space, and a direction is corresponded by a vector. Both can be represented by three-dimensional vectors [15]. Three-dimensional graphics transformation is divided into geometric transformation and projection transformation. The basic geometric transformations are all relative to the coordinate origin, coordinate axes, and coordinate planes. It includes translation, scaling, rotation, symmetry, and offset.

However, the translation transformation cannot be represented by such a matrix, so it follows the homogeneous notation. The point in space is denoted by

$$P = (p_a, p_b, p_z, p_w)_{4 \times 1}. \quad (1)$$

There are $p_w = 1$ of them. In this way, the homogeneous matrix multiplied by the transformation matrix is sufficient to express the changes of the three-dimensional graphics. Then, the transformation of homogeneous coordinates can become a three-dimensional transformation matrix such as

$$\begin{bmatrix} a' & b' & z' & 1 \end{bmatrix} = \begin{bmatrix} a & b & z & 1 \end{bmatrix} T_{3D}. \quad (2)$$

The above 4×4 matrix can be divided into four submatrices according to different graphics transformation functions, such as

$$T_1 = \begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix}. \quad (3)$$

Equation (3) is a 3×3 order submatrix. It corresponds to three-dimensional transformation: symmetry transformation, scale change, rotation, and staggered transformation

$$T_2 = \begin{bmatrix} l & m & n \end{bmatrix}. \quad (4)$$

T_2 is a 1×3 -order matrix, which corresponds to the translation transformation of the point in the three-dimensional transformation, as in the following:

$$T_3 = \begin{bmatrix} p \\ q \\ r \end{bmatrix}, \quad (5)$$

T_3 is a matrix of order 3×1 , which corresponds to perspective transformation in three-dimensional transformation. It assumes that there is a point P in three-dimensional space waiting to be transformed. Its original coordinate is $p(a, b, z)$. After three-dimensional geometric transformation, the coordinate of this point changes to $p'(a', b', z')$.

If the point is obtained after the point P is translated and transformed, it can be expressed as

$$\begin{bmatrix} a' & b' & z' & 1 \end{bmatrix} = \begin{bmatrix} a & b & z & 1 \end{bmatrix} T_t = \begin{bmatrix} a + T_a & b + T_b & z + T_z & 1 \end{bmatrix}. \quad (6)$$

If the result of $a + T_a$, $b + T_b$, and $z + T_z$ are negative, it means that its movement direction is the negative direction

of the coordinate axis. If the point P is scaled, p' can be expressed as (7) in the following form:

$$\begin{bmatrix} a' & b' & z' & 1 \end{bmatrix} = \begin{bmatrix} a & b & z & 1 \end{bmatrix} T_s = \begin{bmatrix} ax & ey & iz & 1 \end{bmatrix}, \quad (7)$$

a, e, i are the scaling factors in the x, y , and z directions, respectively. When $a = e = i$, it means that it performs the overall scaling. When they are not equal, it means that it performs local scaling. In this way, the scaling ratios of the three directions are not equal, and the original object will be deformed.

If the object is rotated around the coordinate axis, p' can be expressed in the form of Equations (8)–(10):

When it rotates around the z -axis, it is represented as

$$\begin{bmatrix} a' & b' & z' & 1 \end{bmatrix} = \begin{bmatrix} a & b & z & 1 \end{bmatrix} T_{rz} = \begin{bmatrix} a \cos \theta - b \sin \theta & a \sin \theta + b \cos \theta & z & 1 \end{bmatrix}. \quad (8)$$

When it rotates around the x -axis, the representation is as shown in:

$$\begin{bmatrix} a' & b' & z' & 1 \end{bmatrix} = \begin{bmatrix} a & b & z & 1 \end{bmatrix} T_{rx} = \begin{bmatrix} a & b \cos \theta - z \sin \theta & b \sin \theta + z \cos \theta & 1 \end{bmatrix}. \quad (9)$$

When it rotates around the y -axis, it is expressed as

$$\begin{bmatrix} a' & b' & z' & 1 \end{bmatrix} = \begin{bmatrix} a & b & z & 1 \end{bmatrix} T_{ry} = \begin{bmatrix} a \sin \theta + z \cos \theta & b & a \cos \theta - z \sin \theta & 1 \end{bmatrix}. \quad (10)$$

Among them, θ represents the rotation angle of the object. It transforms the object that was originally in the form of a three-dimensional image and finally displayed in the form of a two-dimensional image, which is called projective transformation [16]. Projection transformation is the process of transforming the coordinates of one map projection point into the coordinates of another map projection point. It studies the theory and method of coordinate transformation of projected points. Perspective and parallel projections are two of the more commonly used types of geometric plane projections. The unity3D engine will perform mutual conversion between the two projections according to the specific situation, as shown in Figure 3:

As shown in Figure 3, parallel projection is the projection of graphics onto the projection surface along parallel lines, which can ensure that the relative proportions of objects do not change. Perspective projection is the projection of graphics onto the projection surface along a straight line that converges to the projection center, which can produce a sense of reality near large and far small [17, 18]. If the light source S moves to infinity, the projection lines become parallel lines, and the projection of the object is not affected by the distance change. The projection method in which the projection lines are all parallel to each other is called the parallel projection method.

Figure shows the principle of projection transformation, which is similar to the pinhole imaging phenomenon. In the 3D space, the point P takes the origin as the projection center, and now it is necessary to calculate the new y coordinate [19]. From similar triangles, it can be known that

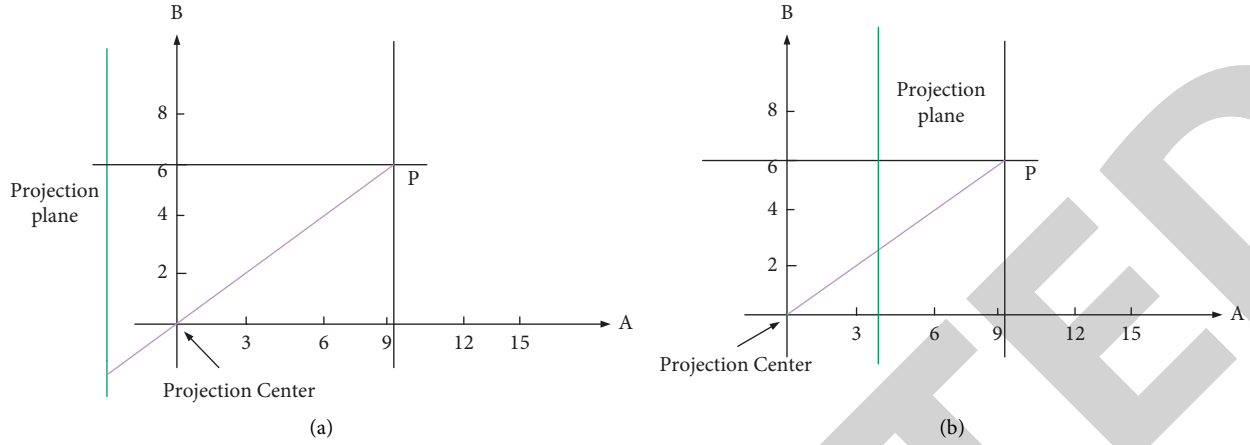


FIGURE 3: Parallel projection in digital twin technology. (a) The principle of projection transformation. (b) The projection transformation principle after converting the projection plane.

$$\frac{-pb'}{d} = \frac{pb}{z}. \quad (11)$$

It leads to

$$pb' = \frac{-dp_b}{z}. \quad (12)$$

Therefore, the result of the projection of the point $P(a, b, z)$ through the origin to the plane $Z = -d$ is

$$p' = \begin{bmatrix} a' \\ b' \\ z' \end{bmatrix} = \begin{bmatrix} \frac{-da}{z} \\ \frac{-db}{z} \\ -d \end{bmatrix} = \frac{-1}{dz} \begin{bmatrix} a \\ b \\ z \end{bmatrix}. \quad (13)$$

In practical applications, the minus sign would cause unnecessary complexity. The p' at this time is

$$p' = \begin{bmatrix} a' \\ b' \\ z' \end{bmatrix} = \begin{bmatrix} \frac{da}{z} \\ \frac{db}{z} \\ d \end{bmatrix} = \frac{1}{z_d} \begin{bmatrix} a \\ b \\ z \end{bmatrix}. \quad (14)$$

When it transforms a 4D homogeneous vector into 3D, it divides the 4D vector by p' . It can be reversed to obtain the projection matrix as

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & \frac{1}{d} & 0 \end{bmatrix} \begin{bmatrix} a \\ b \\ z \\ 1 \end{bmatrix} = \begin{bmatrix} a \\ b \\ z \\ \frac{z}{d} \end{bmatrix}. \quad (15)$$

The visual angle display of UI interface is related to its three-dimensional graphics transformation and projection transformation. According to the above derivation, the digital twin opera platform can be built more accurately [20, 21]. The objective function is the performance criterion of the system. It includes lightest weight of a structure, the lowest cost, the most reasonable form, the shortest production time of a product, and the minimum energy consumption. The objective function is given as

$$\min \sigma = \min \sqrt{\frac{1}{N} \sum_{i=1}^N (a_i - 1)^2}. \quad (16)$$

It uses the standard deviation to describe the degree of dispersion among the opera platforms. The degree of dispersion requires the most average, that is, the smallest standard deviation. It is

$$a_i = \int_{t_1}^{t_2} \Phi dt. \quad (17)$$

4. Design of an Opera Culture Platform Based on Digital Twin

The functional design of the digital service platform can be divided into three categories: management and promotion, teaching assistance, and experiential learning. Therefore, the platform is divided into three modules: the opera culture education management subplatform, the opera culture teaching assistance subplatform, and the learning experience subplatform. Through the construction of three modules, it systematically optimizes the management and promotion of opera culture and assists the development of related work of opera culture. It strengthens students' experience and interest in traditional arts, so as to promote the development of traditional culture popularization education.

4.1. System Design Principles.

Consistency principle: generally speaking, the principle of consistency means that in the process of platform

design and development, different user terminals and different modules should be highly consistent in terms of design concepts, model architecture, data standards, etc., so as to facilitate the promotion and maintenance of the platform [22, 23]. At the same time, a unified data standard should be established to facilitate the storage, transmission, and processing of opera resources of different media types [24]. In addition to maintaining the above consistency requirements, the consistency between “emotion” and “environment” should also be highlighted.

Targeted principle: only by guiding users to enter the situation spontaneously to experience, can better results be achieved. Therefore, in the design process, the different needs of different users should also be considered when the technical standards and “situation” are consistent. Aiming at the different users’ focus and habits, diversification and pertinence should be emphasized in the operation interface and user management.

Interactivity principle: good interactivity is one of the basic principles of digital platform design. To give full play to the situational advantages and rely on the Internet and mobile platforms for development and design, the interactive function should be highlighted [25]. The interaction and experience functions are the main highlights of the design and development of this platform based on the theory of situational education. In order to meet the needs of Sichuan Opera’s full experience and interaction based on “situation,” this platform should have functions such as chatting, resource sharing, resource publishing and retrieval, and VR experience.

4.2. System Architecture Design. The design of the digital platform of opera culture should be based on the mobile terminal application APP and the web terminal management background. The mobile phone application can help the teaching subject to carry out the teaching work more effectively, and the students can better learn and understand the opera culture. The organizer can upload the prepared opera cultural materials through the web page of the platform system, and users can learn through mobile phones after simple settings, as shown in Figure 4:

As shown in Figure 4, the Web terminal is the management core of the Sichuan Opera digital education service platform. The user of the management subject supervises and manages the activity process and evaluates the activity effect through the web terminal. The teaching subject uploads relevant courseware through the Web terminal and provides guidance on the acceptance of the subject to teaching. There is a good interactive experience on the web side, and users do not need to refresh the page again. It also acquires data asynchronously through Ajax, and the page displays smoothly.

WEB mainly consists of five parts: user management, process management, promotion management, teaching management, and information management. Information

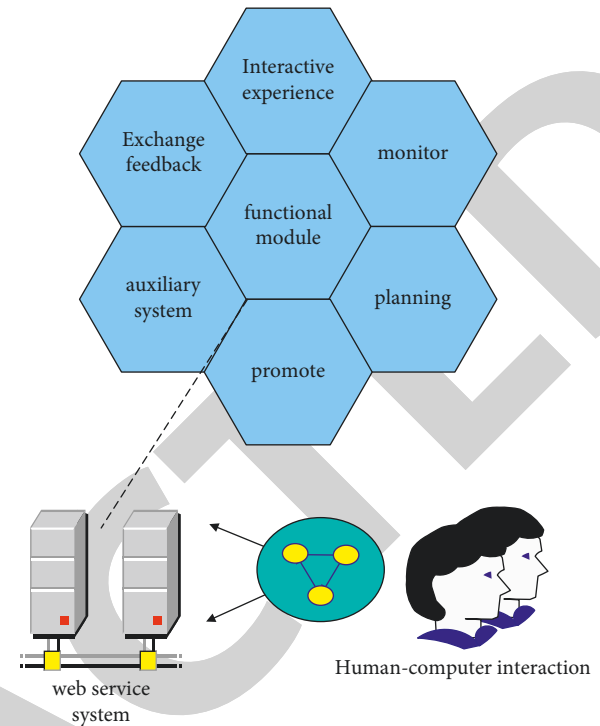


FIGURE 4: Design of the digital platform for opera culture.

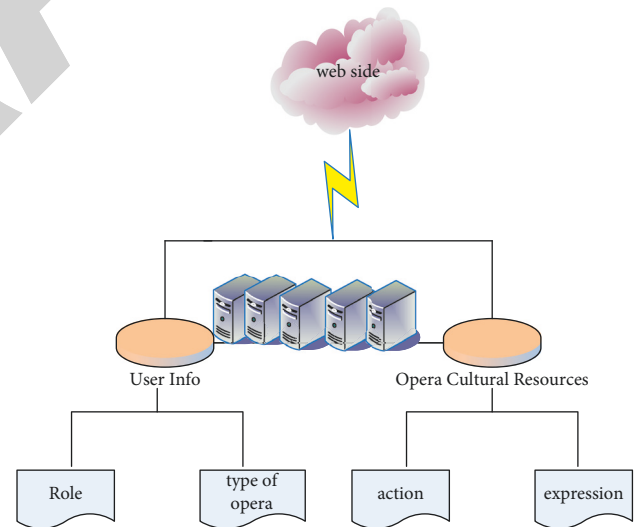


FIGURE 5: Web-side functional flow chart.

management reminds students of their evaluation and feedback information after activities. The teaching subject can grasp the students’ learning situation in time. The functional flow chart of the WEB terminal is shown in Figure 5:

As shown in Figure 5, the main participants of the opera entering the campus are the management learning and teaching. Therefore, the system of the mobile terminal of the digital platform should be designed according to the needs of different participants. Among them, the main body of management mainly manages the resources of opera culture through the web terminal.

4.3. Platform Functional Requirements and Implementation-Taking Sichuan Opera as an Example. Through the functional structure of Sichuan Opera interactive experience platform, the system should have experience management function, real-time experience function, and experience communication function.

4.3.1. Experience Management Function. This function of the system is designed to meet the needs of the teaching subject. The teaching subject can perform necessary management control on the interactive experience module through the terminal. It mainly includes configuring the data resources required by the experience project and regularly updating the data such as Facebook and dressing up. In addition to Sichuan Opera face-changing and Sichuan Opera costumes, it adjusts other unique experience types according to needs, collects experience feelings, and solves problems in the experience.

4.3.2. Real-Time Experience Function. This function is the core function of the system. It can be used by the subject of teaching to interact with relevant content according to personal interests, and it can also be used by the subject of teaching to experience. It mainly includes Sichuan Opera face changing experience, Sichuan Opera dressing experience, Sichuan Opera other unique experience, etc. Because face-changing art is the essence of Sichuan Opera, it plays a more prominent role in the promotion of Sichuan Opera. For this reason, it will be listed separately from the unique experience of Sichuan Opera, so that users can choose the experience.

4.3.3. Interactive Communication Function. This function is for the subject of teaching to exchange feelings with each other according to the experience situation, and for the subject of teaching to communicate with the subject of teaching the specific situation of a certain content. The subject of teaching answers the questions of the subject. This function is an important way for teachers to lead and control the experience process in the popular situational education activities of Sichuan Opera. It mainly includes experience content barrage exchange, post-experience message, experience forum, etc.

The experience management module needs to have the functions of data resource configuration and update, adjustment and setting of experience content, statistics of experience information, and management of experience exchanges. It logs in on mobile terminals such as mobile phones and relies on the system-wide media data center according to the set permissions. Based on streaming media server and portal server, it uploads or publishes various digital resources about the interactive experience of opera [26]. In the process of user experience, it collects user experience data and manages user interaction information based on a distributed interactive platform.

The real-time experience module is the core part of the Sichuan Opera interactive experience platform, and it is also

the key and difficult part of the design. It is mainly the design of the experience content and the way of experience. According to the system functional requirements, this module must have three basic functions: face-changing experience, dress-up experience, and unique experience. It utilizes real-time, accurate gesture dynamic tracking, and facial recognition technology to call the system camera. It tracks the face through the camera and covers the face with hands to trigger interactive commands to change the face. This is very close to the real Sichuan Opera face-changing performance experience.

This session will rely on the reality technology based on digital twin to integrate virtual characters with real scenes. The experience object can choose any place suitable for performance in reality to perform. Different from face changing and dressing up experience, the former is experienced on a virtual stage, while the latter is experienced by virtual characters in an environment consistent with reality. The experience object uses the mobile APP with augmented reality function to detect the environment through the camera, and the real environment is reproduced in the mobile phone.

4.4. International Cultural Communication Strategy Based on Digital Twin Technology

4.4.1. About Cultural Communication. The channels of cultural dissemination include commercial activities, population migration, education, etc. Cultural diffusion is also called cultural diffusion. The main means of modern cultural dissemination is mass media. Cultural exchange can promote the development of world culture. In the era of globalization, every country is committed to improving its economic, political, and military competitiveness in the world. "Soft power," that is, the improvement of the national spiritual and cultural level, also plays a pivotal role. Throughout the world, cultural competition and dissemination has become a historical trend. The dissemination of culture enables the integration of cultures between countries and promotes the production of diverse and characteristic cultures through exchanges.

Today, the world is in the era of digital existence, and the rapid development of information technology has changed the ideas and methods of various communication organizations. The inheritance of culture is an eternal theme. Culture is the soul of a nation and the spiritual pillar for the survival, development, and reproduction of a nation. With the establishment of China's digital culture international dissemination platform, it not only enhances China's cultural content dissemination ability but also enhances the accumulation of China's intellectual property products with international market value.

4.4.2. The Role of Digital Twin Technology in International Cultural Communication. In today's era, culture has increasingly become an important source of national cohesion and creativity. It has increasingly become an important factor in the competition of comprehensive national

strength. However, because China's cultural content industry has been mainly targeting the Chinese market and audience for a long time, it is not familiar with the new market and new audience brought by international opportunities, and does not know enough about the characteristics and needs of the international cultural consumption market. It lacks content offerings and sales channels to enter key markets. Therefore, content products formed only by subjective judgments cannot really produce large-scale market sales and even cannot be accepted by consumers in the target market.

Therefore, if we want to establish an international development strategy for China's cultural content industry, it is urgent to combine digital twin technology with an industrial platform. It is necessary to collect, record, analyze, and judge the user consumption behavior and orientation of the international cultural consumption market and establish a targeted content production direction. This in turn opens up international communication and sales channels for Chinese cultural content products and provides a basic application demonstration for the establishment of a global operation service platform. It finally forms a profitable global operation service platform that can support the internal and external two-way flow of digital cultural content on a global scale, as shown in Figure 6:

As shown in Figure 6, the evaluation feedback system established based on digital twin technology can record and analyze the content selection tendency, usage behavior trajectory, content reading behavior characteristics, and effective user interface of international users from multiple perspectives and multiple level of complex analytical data. It can be combined from multiple dimensions such as hardware environment and network environment and provides valuable guidance for optimizing the propagation direction, propagation mode, user services, and other important links. This saves the cost of dissemination, improves the efficiency of dissemination, enhances the country's core competitiveness, and better enters the international perspective.

5. Experiment and Analysis of International Cultural Communication Based on Digital Twin Technology

5.1. Comparative Experiment and Analysis of International Cultural Communication under Different Communication Modes. Compared with hardware factors such as the country's gross national product and urban construction, the "national soft power" with cultural charm as the main component has gradually developed into an important indicator to measure the country's comprehensive strength. The economic benefits brought by international cultural dissemination to China in recent years are shown in Table 1:

As shown in Table 1, in the new media era with the rapid development of network technology, the previous forms of communication such as newspapers, television, and radio will be replaced by the Internet. International cultural communication can be communicated to the public through various digital communication methods. This paper compares the

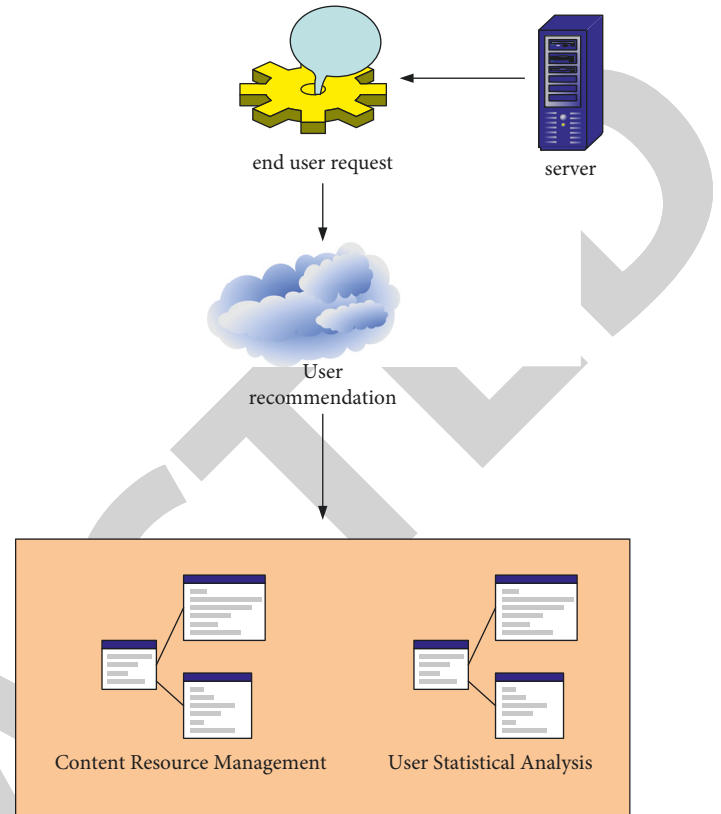


FIGURE 6: International cultural dissemination based on digital twin technology.

TABLE 1: Economic benefits brought by international cultural dissemination to China in recent years.

| Years | Income (billion) | Year-on-year increase | Growth rate (%) |
|-------|------------------|-----------------------|-----------------|
| 2015 | 321.54 | 0 | 0 |
| 2016 | 358.89 | 37.35 | 10.4 |
| 2017 | 435.86 | 76.97 | 17.6 |
| 2018 | 457.64 | 21.78 | 4.7 |
| 2019 | 507.30 | 49.66 | 9.7 |

propagation through traditional methods and methods based on digital twin technology in recent years, as shown in Figure 7:

As shown in Figure 7, in the environment of new technology and new media, it can achieve active dissemination. It actively pushes information to users with potential needs through an interactive platform based on digital twin technology and actively promotes the research of relevant historical materials. It uses the various advantages of the Internet and digital technology to carry out interactive, single-theme distance teaching, which amplifies the significance of international cultural communication.

Information about various cultures is disseminated through media such as newspapers, radio, television, and the Internet. After the audience receives this information, they gain cultural knowledge accumulation. Compared with before, its cognition of culture has changed to some extent. However, under the previous form of cultural dissemination, the audience generally has high recognition and low

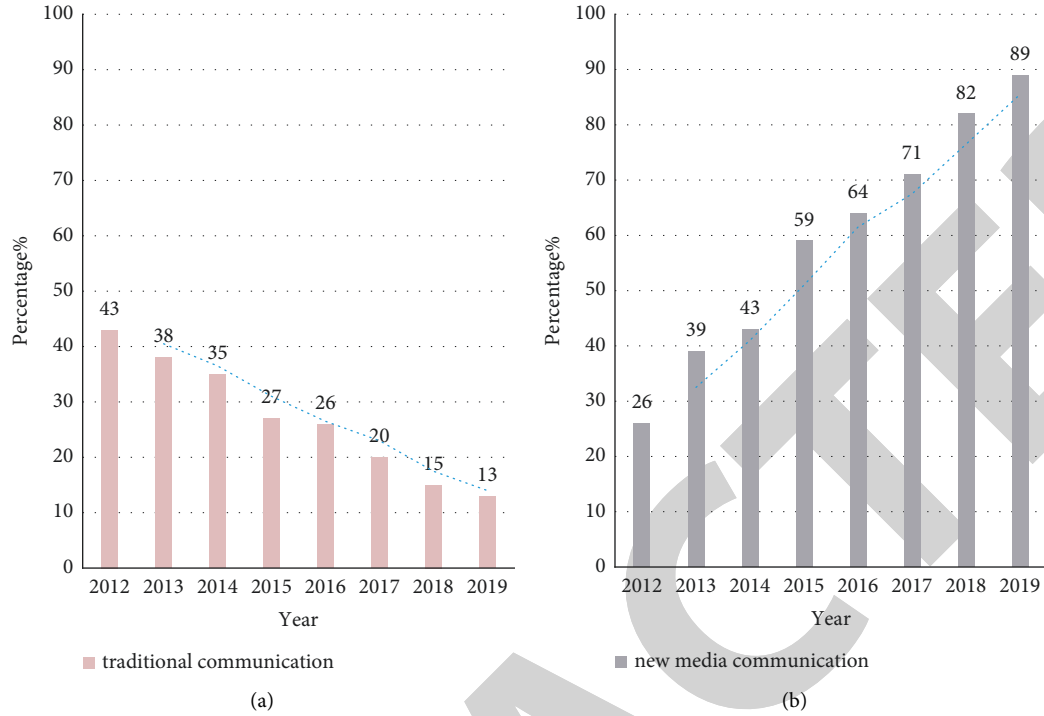


FIGURE 7: Comparison of traditional methods and methods based on digital twin technology. (a) Development trend of traditional communication. (b) Development trend of communication based on digital twin technology.

recognition of traditional culture. This article surveys 100 people who love international culture. Their basic information is shown in Table 2:

As shown in Table 2, among the 100 surveyed people, the ratio of male to female is basically the same. In terms of age, there are more people aged 25–40 years. In terms of education, the proportion of junior high school and above is more.

This article analyzes the 100 people's recognition and awareness of international culture, as shown in Tables 3 and 4:

As shown in Tables 3 and 4, most of the public have a strong sense of identity with a long-standing international culture. It can be seen that the public's basic recognition of international culture is very high. There are 51 people who identify with international culture very much, accounting for 51%. But only 12 people are aware of international culture, accounting for 12%. However, the vast majority of the interviewed public did not have a deeper understanding and awareness of various traditional cultures. Many interviewees indicated that they had knowledge and heard of these cultures, but they did not have a deeper exploration of the cultural spirit contained in them. There are also some urban youth groups interviewed that their cognition of culture is mostly limited to books and "impression" understanding and still lacks understanding of connotation.

"Internet +" is a brand-new business form in which the Internet has developed to a certain stage. At present, its application fields have spread all aspects of life. This includes the dissemination and application of traditional culture. This paper analyzes the increase in the scale of Internet users in recent years, as shown in Figure 8:

TABLE 2: Basic information of 100 people who love international culture.

| Basic situation | Object | Number of people |
|-------------------|-----------------------------|------------------|
| Age | 25–40 | 55 |
| | Greater than 40 | 45 |
| Gender | Male | 47 |
| | Female | 53 |
| Educational level | Below junior high school | 22 |
| | Junior high school or above | 78 |

As shown in Figure 8, the survey shows that with the continuous development and change of the current media social environment, the audience is very interested in the dissemination of "Internet +" traditional culture. In the era of mobile Internet, the way audiences receive information has changed. The Internet has injected new vitality into the development of traditional culture. The application of traditional culture has become an important form of traditional cultural information dissemination.

This paper analyzes the attitudes of Internet users towards international cultural communication, as shown in Figure 9:

As shown in Figure 9, there are both positive and negative attitudes towards the current Internet international cultural dissemination, but most of them have a positive attitude towards the development of "Internet +" traditional culture. The audience's positive attitude towards the "Internet +" traditional culture shows that the audience has certain confidence in its development, indicating that the audience's attention to the Internet traditional culture is

TABLE 3: 100 people's recognition of international culture.

| Acceptance | Number of people | Percentage (%) | Effective percentage (%) |
|----------------------------|------------------|----------------|--------------------------|
| Very much agree | 51 | 51 | 51 |
| Identify | 30 | 30 | 30 |
| Neither agree nor disagree | 10 | 10 | 10 |
| Not agree | 5 | 5 | 5 |
| Strongly disagree | 4 | 4 | 4 |

TABLE 4: 100 people's awareness of international culture.

| Acceptance | Number of people | Percentage (%) | Effective percentage (%) |
|-----------------------|------------------|----------------|--------------------------|
| Know very well | 12 | 12 | 12 |
| General understanding | 20 | 20 | 20 |
| Do not understand | 43 | 43 | 43 |
| Very ignorant | 25 | 25 | 25 |

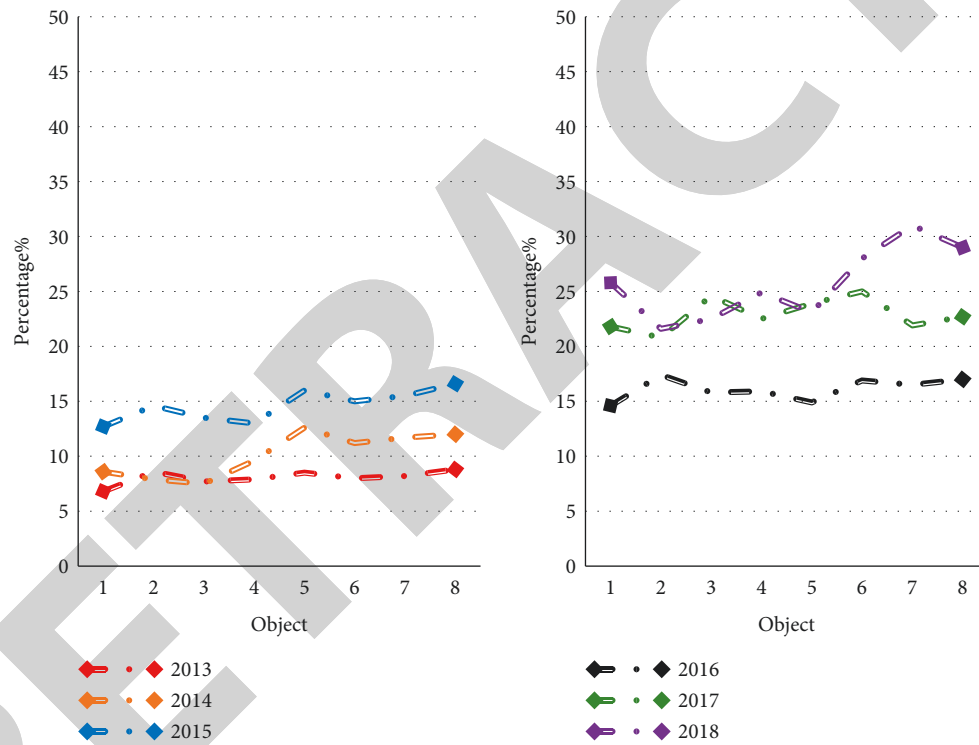


FIGURE 8: Increase in the scale of Internet users from 2013 to 2018.

gradually increasing. To a certain extent, this shows that the audience's interest in international culture on the Internet has increased.

5.2. Implementation of International Cultural Communication Strategy

5.2.1. Fully understand the Cultural Background. When engaging in cross-border communication of cultural brands, understanding the cultural background and mental characteristics of the audience in the importing country is the first task for cultural brand operators to do well. From the perspective of positioning, the audience is always the first to accept the things that already exist in the mind. For Chinese

cultural brands, how to combine the value connotation conveyed by their own brands with the mental characteristics of overseas audiences is the key factor to take the lead in communication. This requires people's operators to pay attention to overseas audience market research and to put an end to the "product"-based communication strategy.

5.2.2. In-Depth Research on Cultural Products. It is necessary to conduct in-depth research on the consumption experience habits of cultural products of overseas audiences, and based on this, it enrich the experience and technological extension of their own culture. Chinese culture often has problems of monotonous experience and monotonous content. It needs to make extensive use of the opportunities

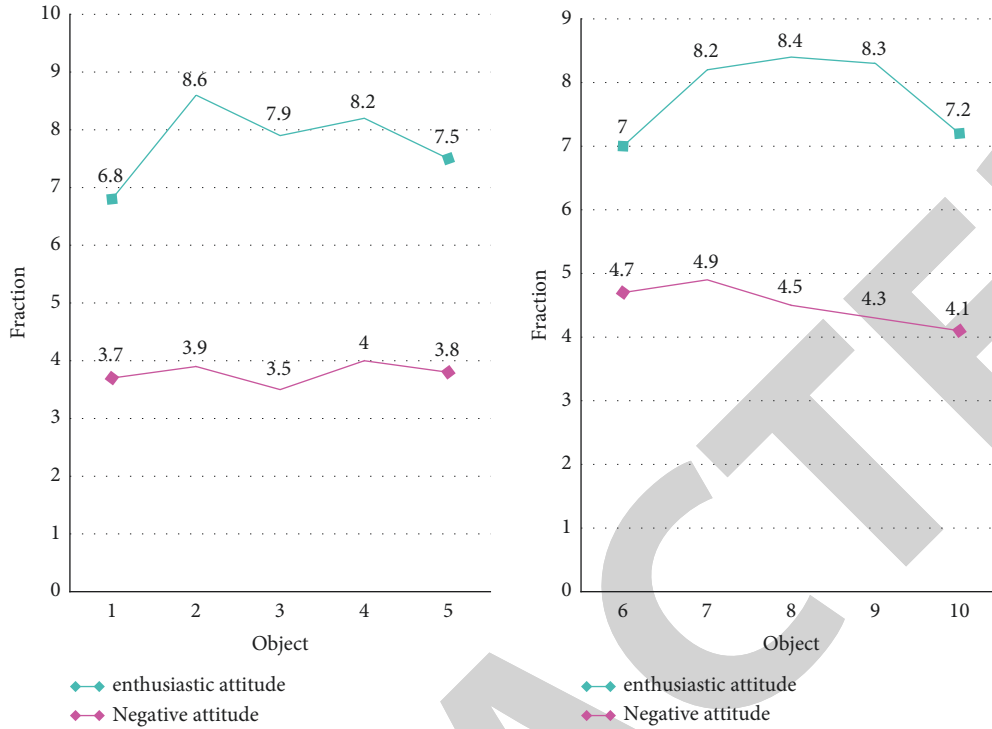


FIGURE 9: Attitudes of Internet users towards international cultural communication.

brought by technological innovation to create a variety of brand display and experience forms. This comprehensive brand communication strategy needs to be adopted to maintain the vitality and freshness of the brand.

5.2.3. Adhere to the Unique National Character of the Brand.

It is necessary to adhere to the unique national character of the brand and emphasize cultural communication and mutual learning. Unique nationality is the core selling point of cultural brands in international communication. Although it is necessary to consider the acceptance habits and mental characteristics of overseas audiences in terms of communication methods and strategies, it is still the core competitiveness of the brand nationality that can move people's hearts. To let the audience understand that the nationality of cultural brands is not something illusory, it is necessary to carry out cultural communication and mutual learning, such as in communication. It is necessary to appropriately adopt a light and lively humorous form to bring the seemingly inscrutable Chinese culture closer to the hearts of ordinary overseas people.

6. Conclusions

Driven by new media, through visual design, the story of opera is transformed into visual images and applied to digital image interaction. In the process of unintentional interaction, the public realizes the understanding and perception of the opera culture through the change and collision of thinking, thus awakening the public's perception and attention to the opera culture. Now opera is the main body of cultural activities in civil society. Chinese opera embodies

the most extensive aesthetic taste and appreciation taste and has become the unanimous hobby of many people from urban to rural areas. Opera is also an important carrier for disseminating traditional Chinese cultural values. In the media selection of opera culture, it should face the media carrier with publicity and mass. Ontology can be better spread only if it constantly adapts to social and cultural needs and aesthetics. With the development of digital twin technology, people have begun to apply this technology to the design of opera cultural platforms and the dissemination of international culture. This paper expounds the design of the platform of opera culture and the concept of international cultural dissemination. In the Methods section, some methods of digital twins are described. Through analysis, we know that international cultural communication is very important for a country. It can not only satisfy people's spiritual needs but also improve economic efficiency. In the experimental part, this paper analyzes the traditional dissemination method and the dissemination method based on digital twin technology and finds that the dissemination method based on digital twin technology is more popular. Due to the complexity of cultural origins, cultural dissemination methods and paths, and factors that affect the diffusion, it is difficult to explore the origin of a certain cultural feature in cultural geography research.

Data Availability

No data were used to support this study.

Conflicts of Interest

The author declares that there are no conflicts of interest.

Retraction

Retracted: Design of Hybrid Teaching System for Aerobic Exercise Class of Recreational Sports Major

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] S. Yang and X. Mao, "Design of Hybrid Teaching System for Aerobic Exercise Class of Recreational Sports Major," *Mobile Information Systems*, vol. 2022, Article ID 1491480, 12 pages, 2022.

Research Article

Design of Hybrid Teaching System for Aerobic Exercise Class of Recreational Sports Major

Sha Yang¹ and Xiulei Mao²

¹Department of Physical Education, Lvliang College, Lvliang, Shanxi 033000, China

²Jeonju University, Jeonju, Jeollabuk-do 55060, Republic of Korea

Correspondence should be addressed to Sha Yang; 20131114@llu.edu.cn

Received 23 May 2022; Revised 16 June 2022; Accepted 21 June 2022; Published 4 August 2022

Academic Editor: Amit Gupta

Copyright © 2022 Sha Yang and Xiulei Mao. 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 recent years, the social economy has achieved remarkable development, and the income of residents has increased substantially. With the increasing income, residents begin to pursue a high quality of life, and the ways of entertainment also begin to become diversified. In this context, leisure sports have gradually come into the public's view, and more and more people have started to participate in leisure sports. Aerobic gymnastics, as a popular form of fitness, is an important carrier to carry out national fitness sports and promote national health, and the development of national fitness sports cannot be carried out without scientific and effective aerobic gymnastics teaching, training, and guidance. At the present stage, the traditional aerobics teaching content and teaching methods of leisure sports majors are difficult to meet the needs of students learning. Therefore, the hybrid teaching system of aerobics classes based on cloud computing and neural networks is proposed, which combines the advantages of a network teaching and traditional teaching to comprehensively and effectively improve the efficiency and quality of aerobics teaching and improve the classroom teaching effect. At the same time, it promotes leisure sports students to systematically master the basic theoretical knowledge, skills, and methods, improve the comprehensive ability of independent learning and inquiry learning, have the ability of leisure sports program guidance and aerobics teaching organization, enhance their employability, and cultivate "multidiscipline" students who can adapt to the needs of the times and engage in technical guidance of aerobics and participate in leisure sports market services in leisure fitness clubs, industry associations, and educational institutions. This course aims to cultivate "multidiscipline" applied talents who can work in leisure and fitness clubs, industry associations, and educational institutions.

1. Introduction

In recent years, with the rapid development of the national economy, residents' health awareness has been increasing, and people have a higher pursuit of quality of life, more rational participation in leisure sports activities, and more attention to the quality of leisure. Fitness clubs, golf courses, multifunctional sports and leisure centers, SPA pavilions, and other leisure venues have increased accordingly. The rapidly expanding leisure sports market has raised higher requirements from the safety and security of sports, the professional quality of practitioners, scientific fitness guidance, to the health conditions of fitness venues, medical supervision, nutrition consultation, fitness evaluation, etc.

The service of the leisure sports industry is gradually scientific, professional, and standardized. At present, different levels of universities and colleges are opening leisure-related majors or directions one after another. Recreational sports is an emerging profession in the field of physical education in China, and the direction and idea of running the school, talent training mode, and way are yet to be thoroughly investigated [1–3]. The work process is a complete work procedure in which a work result is obtained to complete a work task. Work process-oriented teaching is based on the actual work of vocational job groups so that all elements of vocational activities can be infiltrated and integrated into the teaching process, in the school's teaching environment, teaching management, and other aspects, thus forming a

vocational curriculum system and teaching environment. The students trained through this environment are full of professionalism and become the talents needed by society. The principles of aerobics curriculum design are shown in Figure 1.

The combination of engineering in the leisure sports program adopts the integrated training mode of “teaching and doing.” The key is to develop a systematic work process curriculum system. The construction of the work process systematic leisure sports curriculum system mainly includes the following five steps. According to the market and social demand research and analysis, establish the training objectives and locate the employment positions of graduates. Track and research the situation of enterprises and graduates, refine typical work tasks, and carry out teaching design. On the basis of the preliminary analysis and generalization, carry out the arrangement of teaching action areas. Refine and sublimate the contents of the learning areas and transform them into competencies. Design the learning situation, select the carrier of the same category and build a typical model to promote it. The standard leisure sports industry chain includes leisure education, technical guidance of leisure sports, operation and management of sports and leisure venues, sports product design and services, and planning and marketing of leisure sports events. The profession is positioned to cultivate talents in leisure education, leisure sports venue operation and management, leisure sports project development, and leisure product promotion. Aerobics has the meaning of aerobic gymnastics in foreign countries, also known as aerobic gymnastics and aerobic dance, with the characteristics of aerobic exercise [4]. From the exercise purpose and task, aerobics can be divided into fitness aerobics, competitive aerobics, performance aerobics, and fitness aerobics; its audience is mainly the public, so it is also known as public aerobics or aerobic fitness exercise. According to Zou [5], aerobics is a component of aerobics exercise, which is a continuous exercise for more than 15 minutes with musical accompaniment. School regarded aerobics with aerobic exercise characteristics as aerobic gymnastics, using aerobics exercises or dance combinations and other movements to continuously complete more than 12 minutes of movement content with a certain exercise load. Aerobic gymnastics exercise is based on aerobic training, with health, strength, and beauty as the characteristics of the heart, fitness, beauty as the purpose, set music, dance, and gymnastics in one. Compared with other projects, aerobics most prominent feature is to improve the practitioner’s cardiopulmonary function and promote the cardiovascular system to transport oxygen to all parts of the body so as to mobilize the body to participate in sports. Practitioners, each practice time at least 15 minutes, at least three times a week, practice and maintain a certain heart rate, in order to achieve good exercise results. During the exercise, the heart rate is controlled to within 60%–80% of the maximum heart rate. From the comprehensive view of the above scholars, aerobic exercise is summarized as follows: in the musical accompaniment, gymnastics, aerobics, dance, and other content, aerobic exercises as the basis of exercise, health, strength, and beauty as the characteristics of

exercise are used, so as to achieve health, fat loss plasticity, and pleasure body and mind for the purpose of a fitness exercise [5–7].

Teachers play a leading role in knowledge transfer and skills teaching activities. Although this model is helpful for the successful completion of teaching tasks and students’ systematic mastery of knowledge, the way information is transferred between teachers and students is one-way, resulting in a passive state when students receive knowledge. Second, in aerobics technology class teaching, many aerobics technical movements are following the music instantly, and students are facing difficulty comprehending and mastering aerobics technical movements in a timely and comprehensive manner, thus appearing irregular technical movements; over time will make students feel dependent, affecting the students’ learning of knowledge and skills. Finally, in the current aerobics class the student knowledge and skills levels vary, some students in the class have a “not enough” phenomenon, and it is difficult to meet the needs of individual student development [8–10]. Therefore, the integration of blended teaching into aerobics teaching not only meets the trend of information technology teaching reform but also meets the development needs of students with different levels of knowledge and skills. This is of great significance to the change of aerobics teaching, the improvement of teaching quality, and teaching efficiency. The main contributions of this article are as follows. (1) It analyzes that, at this stage, the traditional aerobics teaching content and teaching methods of leisure sports majors can hardly meet the learning needs of students. (2) It proposes a hybrid teaching system of aerobics classes based on cloud computing and neural network, which combines the advantages of online teaching and traditional teaching to comprehensively and effectively improve the efficiency and quality of aerobics teaching and improve the classroom teaching effect. (3) This course aims to cultivate “multidisciplinary” applied talents who can engage in leisure sports market services in leisure and fitness clubs, industry associations, and educational institutions.

2. Related Work

2.1. Leisure Sports Profession. Accelerate the training of sports industry management talents, and point out that the relevant institutions of higher education should actively promote the reform of education and teaching to cultivate specialized talents to meet the needs of sports industry development. The emergence of the concept of leisure sports, on the one hand, shows the modernity of “sports” and another era of transformation of sports culture, or leisure sports is a concentrated embodiment of the conceptualization of contemporary society, economy, culture, and life concept and also highlights the development trend of commercialization, functionalization, and popularization of sports. In recent years, the development of leisure sports in China has been quite rapid, but while the Chinese people are vigorously carrying out leisure and fitness activities, a large number of people who participate in various leisure activities lack the necessary methods and means of leisure and

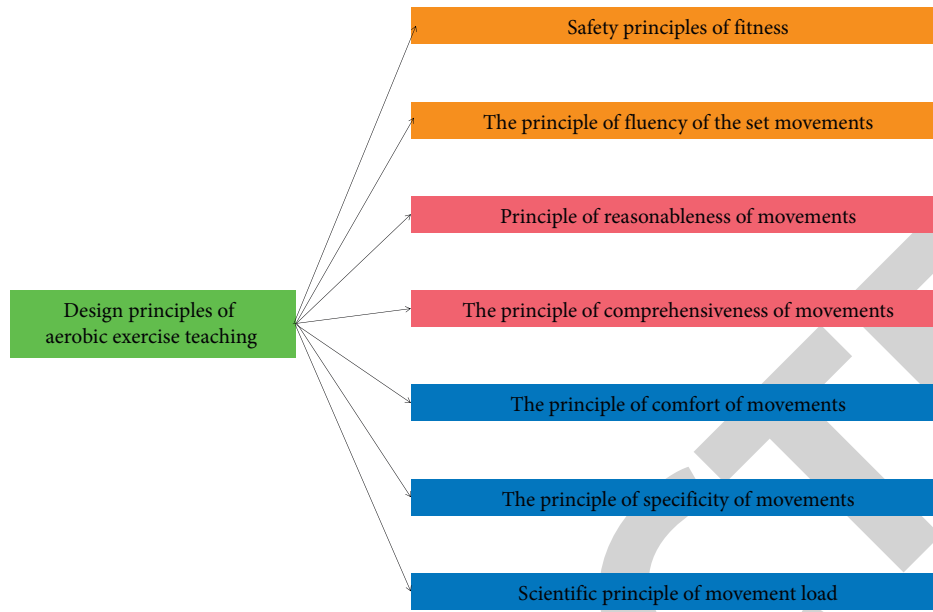


FIGURE 1: Principles of aerobics curriculum design.

recreation, so it becomes more and more necessary and urgent to cultivate leisure sports talents [11–13]. The evaluation system of leisure sports personnel training is a comprehensive and detailed assessment and inspection of the whole personnel training process and its results. Through the evaluation, we can find out the problems in the process of cultivating leisure sports talents and further propose targeted solutions, i.e., the evaluation also includes feedback, which is conducive to the refinement and consolidation of the advantages in the process of cultivating talents. It is both a way to supervise the cultivation of leisure sports talents and a means to guarantee the quality of leisure sports talents cultivation, and the ultimate goal is to promote the sustainable development of talents' cultivation. As an important part of the whole leisure sports personnel training mode, evaluation is throughout the process of training objectives, curriculum development, teaching organization and implementation, and leadership management of leisure sports professionals. Evaluation includes three types of evaluation as follows: preevaluation, process evaluation, and postevaluation. At present, the evaluation subject of Chinese higher education is relatively single. In order to improve the quality of higher education, the evaluation mechanism of multiple subjects should be introduced. The leisure sports profession emerged along with social development and once became a popular profession, so it is more important to absorb the evaluation subjects from the society or the market, so as to understand how the talents cultivated by colleges and universities, which are the main training subjects of leisure sports talents, can meet the needs of the public. In a word, the talent cultivation mode of leisure sports majors is a complex system consisting of talent cultivation goals and talent cultivation measures. Thus, a good evaluation system is built on the basis of a perfect and reasonable curriculum system, and each link of the talent cultivation mode of leisure sports majors is tightly

interlocked and complementary, and only when each link is put into place, the goal of talent cultivation can be realized. Teachers and students are the two most important subjects in the teaching process. Teachers generally implement the whole teaching according to the syllabus, while what teaching methods or teaching methods are adopted in the teaching process will vary from person to person [14–16].

In a broad sense, teaching is education, but here, we take a narrow interpretation, that is, teaching is the activity carried out by teachers and students with certain teaching contents as the medium. The relationship between teaching and curriculum is extremely close. If the cultivation of leisure sports professionals is compared to a project, then the curriculum of leisure sports majors is a construction blueprint, and the teaching of leisure sports majors is a construction process. Therefore, after the curriculum system of leisure sports is designed, teachers and students need to participate in it and implement it with diversified teaching methods, so as to achieve the established goals of teaching or curriculum. Since recreational sports is an imported product and a newly emerged profession based on the degree of social development, teachers engaged in the teaching of recreational sports-related courses have higher requirements. In other words, they have to be aware of the current social context, learn new knowledge, master new skills, and constantly improve their professionalism. At the same time, they should adopt diversified rather than single teaching methods as much as possible in the teaching process to improve the art of teaching, enliven the classroom atmosphere, and motivate students to learn. On this basis, teachers should also pay attention to the combination of theory and practice, the combination of knowledge accumulation and intelligence development, the combination of teacher's dominance and students' subjectivity, etc. This is because teaching is not confined to the classroom, not limited to the transmission of knowledge, and not limited to

the dominance of the teacher, so teachers are fully capable of taking students out of the classroom, tapping into their intelligence, and even allowing them to act as teachers. The activity form of recreational sports provides these possibilities, so teachers can fully use various teaching methods flexibly in the teaching process to achieve the goals of teaching and thus achieve the goal of training recreational sports professionals. Compared with the more mature social sports guidance and social sports management majors, leisure sports majors are relatively new and have a late start and still need to be explored. With more and more people participating in recreational sports in China, the recreational sports industry also has more room for development. Then, the market demand for recreational sports talents is increasingly urgent. This requires the universities that have opened leisure sports majors and those that are going to open leisure sports majors to respond to the needs of society, adapt to the development of the times, and continuously improve the quality of the cultivation of the majors. On the other hand, they should reflect on the problems in the development of leisure sports majors, explore the distinction between them and social sports guidance and social sports majors, and furthermore improve the construction of the majors. Finally, they can better serve the leisure. On the contrary, we will reflect on the problems in the development of leisure sports and explore the distinction between it and social sports guidance and social sports, so as to further improve the construction of this major [17–19].

2.2. Hybrid Teaching in Aerobics Class. Blended teaching is a student-centered educational paradigm, whose core concept is a subversive innovation of mixing teaching elements to achieve the most optimal effect; its profound connotation is to provide students with appropriate learning content, appropriate learning techniques, and other multifaceted information at the right time and space; its core idea is to use different teaching methods, constantly optimize the teaching process, in the choice of teaching mode. Effective streamlining of costs: the core idea is to optimize the teaching process by using different teaching methods and to streamline the cost effectively in the selection of teaching modes. The learning theory of blended teaching is guided by behaviorism, constructivism, cognitivism, etc., and the teaching mode is to optimize and integrate teaching resources with the help of information technology and to obtain a good teaching effect. As a new idea of reform and innovation of education informatization in the era of “Internet+,” blended teaching has been widely recognized [20]. To effectively grasp this learning paradigm, we should first grasp its basic features. Firstly, it is the integration of resources, environment, interaction, monitoring, management, and other teaching elements. Secondly, it is a mixture of the construction of curriculum teaching resources in accordance with students’ cognitive process. Thirdly, the teaching concept is student-centered; the teaching method highlights autonomy and flexibility. Fourthly, it is the reconstruction of teaching structure, in the teaching process, highlighting the practical teaching design and highlighting

the relevance and timely feedback. Lastly, the evaluation method is mixed with all-round and multiangle. Table 1 is a comparison of the differences among traditional teaching, online learning, and blended teaching.

In blended teaching, giving full play to the leading role of teachers as well as mobilizing students’ subjectivity is the primary principle followed in the design and implementation of blended teaching. First of all, the focus of respecting student subjectivity is to stimulate the initiative of student learning. In the leisure sports professional aerobics class hybrid teaching design, the teaching environment, as well as the creation of the learning environment, should take into account the students’ ideas, focus on student initiative, flexible use of learning resources, moderate the initiative of learning to students, the formation of the teacher’s regulation and training in the teacher’s autonomy, and the sense of dynamic acquisition of knowledge, and consciously form the habit of learning. Second, teachers help students learn as supporters, guides, and facilitators. The teacher’s dominance is reflected in the control of the rhythm of the entire classroom, and the teaching design of the course is adapted to the cognitive laws of students, while providing students with rich learning resources, learning guidance, and convenient learning conditions to efficiently achieve teaching goals, highlighting the timeliness and efficiency of online instruction [21, 22].

The core point of aerobics is aerobic; therefore, in the actual exercise process, teachers should effectively integrate the concepts of aerobics as well as calisthenics and build a new concept on this basis to stimulate students’ curiosity about aerobics and then motivate them to actively approach aerobics. Aerobic exercise not only helps students to develop a lifelong fitness philosophy but also helps teachers to achieve health-oriented physical education goals. Teachers also need to use network technology to build an interactive platform to share aerobic exercise resources to improve their teaching level. With the help of the network platform, teachers can communicate with each other about their actual teaching experience and share teaching resources so that they can learn from each other’s strengths and complement each other’s weaknesses, which will gradually improve the aerobics curriculum teaching system and make its teaching value fully reflected.

3. Methods

3.1. Model Architecture. The hybrid teaching system for aerobics classes proposed in this paper is based on a cloud computing platform. Cloud computing is a model for increasing, using, and delivering Internet-based related services; a model that allows fast and efficient access to resources, including networks, servers, storage, and application software, according to user needs through available and convenient network access and is characterized by being dynamic, easily scalable, and often virtualized. The cloud computing environment consists of a network environment where computing and storage coexist, on which cloud platforms and cloud services are hosted. The main architecture of the cloud platform consists of two parts as follows: the bottom layer is

TABLE 1: Comparison of the differences among traditional teaching, e-learning, and blended learning.

| | Traditional teaching | E-learning | Blended learning |
|----------------------|----------------------------|--------------------------------|--------------------------------------|
| Teaching philosophy | Teacher-centered | Student-centered | Student-centered |
| Teaching method | Indoctrination | Inquiry-based | Teacher teaching + student inquiry |
| Teaching environment | Face-to-face classroom | Virtual classroom | Online + offline |
| Teaching resources | Book-based knowledge | Web resources | Book knowledge + internet resources |
| Teaching evaluation | Single evaluation | Evaluation single | All-round and multi-angle |
| Teaching interaction | Face-to-face communication | Network platform communication | Face-to-face + network communication |

servers, storage, and network switching devices connecting them, and the upper layer is various system software and support software, including operating systems, virtualization software, distributed and parallel processing software, distributed storage, cloud-capable service programming interfaces, and various application service interfaces. And cloud services are based on the information technology needs of various industries to deploy and deliver application software generation to build a system model to combine cloud computing, cloud platform, and computer experimental teaching; the first step is to build a hybrid teaching system model based on cloud computing aerobics class. The hybrid teaching system of aerobic exercise class mainly relies on the cloud platform for development, and then various aerobic exercise class services and needs are arranged and deployed on the platform, the main users of the platform include students, instructors, laboratory managers, and teaching managers; according to the use of demand, the hybrid teaching system of aerobic exercise class based on cloud computing proposed in this paper is shown in Figure 2.

3.2. Image Visual Processing Module. One of the most prominent features of the cloud computing teaching system is that the system should be both audio and visual; then, the issue of image processing becomes the highlight of the system innovation. Using the parallel programming model and computing framework of the Hadoop MapReduce platform provided by cloud computing and the parallel computing of massive data sets, we can provide effective support for data-intensive applications and thus is very suitable for parallel digital image processing. However, due to the wide variety of image information to be processed by the hybrid teaching system, the requirements for real-time, interactivity, image clarity, and browsing speed are high, and only the built-in data types of Hadoop cannot directly act on the MapReduce framework to process images. Therefore, an image processing class is customized to meet the image requirements of this system in the cloud computing environment. A custom *ImageDisposal* class based on the MapReduce workflow is used to complete the processing operations of image information in the hybrid teaching system. The following is a schematic diagram of the image information processing process from a macroperspective. The flow of the vision processing module is shown in Figure 3.

The class mainly inherits the Writable interface, *WritableComparable* interface, *InputFormat* class, *RecordReader* class, *InputSplit* class, and *OutputCollator* class from Hadoop, and specifies and overrides the corresponding interfaces and

the inherited subclasses. The writable interface defines two methods, *DataOutput* and *DataInput*, which are overridden in the *ImageDisposal* class, which implement the write and read operations of the image information data. There are image location information, in which the upper left corner of the screen is the origin (0, 0) point of the plane right-angle coordinates, and the location of the left X-axis and down Y-axis coordinates, i.e., (x, y) point; image size information, which identifies the height and width of the image, and the scaling ratio adjusted randomly according to the size of the browser; image storage information, which is the complete storage path of the image, including the image name and *InputFormat* class *InputFormat* class mainly completes the definition of the input format because the image information is large, so *ImageDisposal* class uses a file as the data source for input, inheriting from the *InputFormat* class *FileInputFormat* subclass, resulting in a new subclass named *ImageDisInputFormat*, which is responsible for splitting the pre-processed image information that has been ordered in the split piece into records. According to the image information to be delivered in the hybrid teaching system, the user can define the size of the record in advance. In this system, for different types of images, such as images with high-definition requirements, images with fast transmission speed requirements, images with large storage space requirements, and small images with high resolution, the size of the record is divided into different bytes accordingly in order to meet the needs of various types of images. The key of <key, value> key-value pair is Text, which is used to store the storage path of the segmented subimage in the file; the value is a record of the *ImageDisposal* class.

3.3. Data Storage and Reading. HBase is an open source, highly reliable, high-performance, column-oriented, and scalable nonrelational distributed database. As part of the Hadoop project, HBase can run on top of the HDFS file system to store massive amounts of unstructured and semi-structured loose data, while ensuring high fault tolerance and improving the reliability of the system. Unlike traditional relational databases, HBase uses simpler data types and data operations do not contain complex table-to-table linking relationships, only simple queries, deletions, insertions, and empties; in terms of the storage model, relational databases are row-based, while HBase is column-based, and files of different column families are isolated from each other; in terms of data indexing, HBase scans and accesses the entire database through only one index, the row key; in terms of data maintenance, an update operation in a relational database causes the original old values to be replaced, while when an

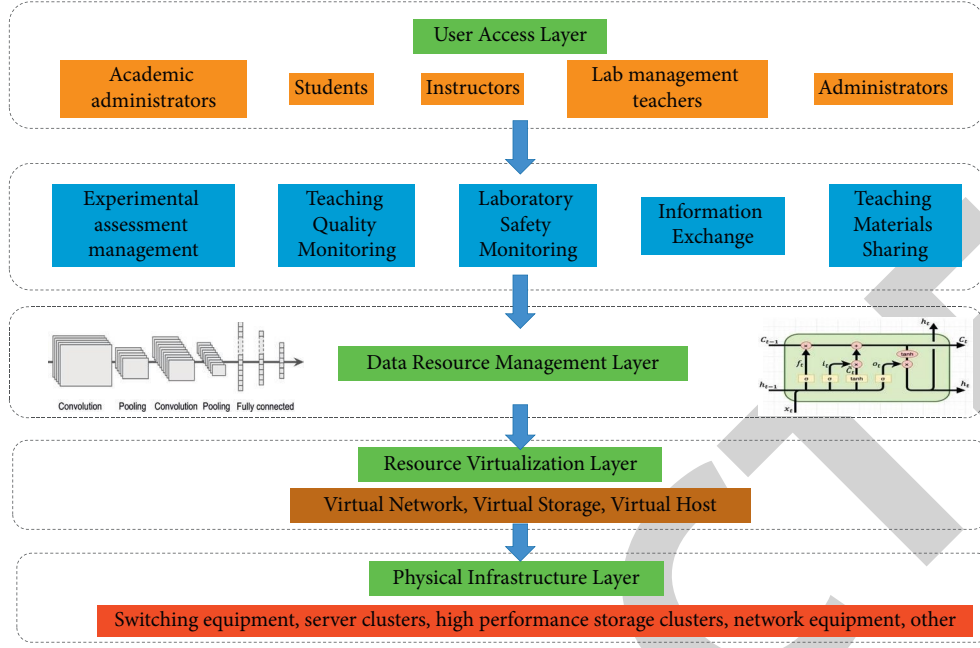


FIGURE 2: Model structure.

update operation is performed in HBase, the old data remain and a new version of the new data is generated. The system architecture of HBase is shown in Figure 4.

3.4. Aerobics Movement Correction System. According to the hardware framework and equipment selection results of the cloud computing system set above, in this design, the aerobics movement correction system module of the system is embodied in the way of the running process.

The processed image is stored in the unified database, and the processing is unfolded using the directional gradient histogram. Firstly, the motion image is transformed into the form of a static image, and the image is transformed into a grayscale map using a gamma algorithm, and the specific processing process is as follows:

$$A(x, y) = A(x, y)^{\text{gamma}}, \quad (1)$$

where $A(x, y)$ denotes the pixel value of the pixel point (x, y) in the image and gamma is set to 0.45 based on previous processing experience. Set the gradient of this data point to the first order derivative, and its quadratic function can be expressed as $f(x, y)$; then, its gradient formula can be expressed as follows:

$$\begin{aligned} \nabla f(x, y) &= \begin{pmatrix} E_x \\ E_y \end{pmatrix} \\ &= \begin{pmatrix} \frac{\alpha f}{\alpha x} \\ \frac{\alpha f}{\alpha y} \end{pmatrix}, \end{aligned} \quad (2)$$

where E_x denotes the gradient in the x -axis direction in the image and E_y denotes the gradient in the y -axis direction in the image, and the following formula is used to calculate the gradient of the pixel point in this design:

$$\begin{cases} E_x(x, y) = A(x+1, y) - A(x-1, y), \\ E_y(x, y) = A(x, y+1) - A(x, y-1), \end{cases} \quad (3)$$

where E_x and E_y are the gradient values of (x, y) in the horizontal and vertical directions, respectively, and $A(x, y)$ is the grayscale value of (x, y) , and the gradient is calculated using the grayscale values of the four-pixel points of this pixel point cycle to obtain the gradient increase and motion direction of the athlete's training activities, and the specific formula is shown below:

$$\begin{aligned} E(x, y) &= \sqrt{E_x(x, y)^2 + E_y(x, y)^2}, \\ \beta(x, y) &= \arctan\left(\frac{E_y(x, y)}{E_x(x, y)}\right). \end{aligned} \quad (4)$$

Formula (4) represents the gradient increase of the training activities and represents the motion direction of the action. The above calculation part determines the basic content of the athlete's movement to provide the basis for the subsequent detection.

Based on the determined direction of movement, the approximate range, and direction of movement of the athlete are obtained. To make the results of this study accurate, secondary processing of the acquired images is performed using *OpenPose* software, a software module that allows for multiperson pose processing. In this processing, the athletes' movement joints were recorded using the *OpenPose* method, and the upper body joints and lower body joints of the movement were divided using the serial numbers. Using the

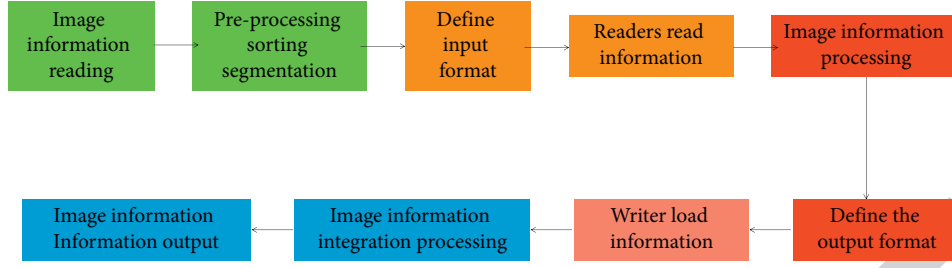


FIGURE 3: Vision processing module flow.

results of the above serial number setting, the acquired images are subjected to part closeness inference, and the image joint motion phase is set to $a \in [1, \dots, A]$ using the convolutional pose machine, and the image joint motion structure is set to the branch input form. In the first stage, the $(W^1 = \chi^1(B))$ of the image of the joint part and its closeness to other joints can be expressed as $(P^1 = \delta^1(B))$, where χ^1 and δ^1 denote the processing of the convolutional layer of the system, respectively. In each stage, a feature extraction will be performed as the input value in this stage, which is used to generate more accurate prediction results of the athlete's movements, and the specific process can be expressed as follows:

$$\begin{aligned} W^t &= \chi^t(B, W^{t-1}, P^{t-1}), \quad \Delta t \geq 2, \\ P^t &= \delta^t(B, W^{t-1}, P^{t-1}), \quad \Delta t \geq 2. \end{aligned} \quad (5)$$

Using formula (5), the inference process is completed. To avoid the corresponding loss of information in the image during the process, the corresponding loss function is set to control the operation process:

$$\begin{aligned} f_W^T &= \sum_{i=1}^i \sum U(l) * W_i^T(l) - W_i^*(l)_2^2, \\ f_P^T &= \sum_{i=1}^i \sum U(l) * P_i^T(l) - P_i^*(l)_2^2, \end{aligned} \quad (6)$$

where $W_i^T(l)$ denotes the label of the joint in the image, which is represented by two sets of output feature values, where one set denotes the x -axis in the image and the other set denotes the y -axis in the image, and each position denotes x and y of the location of the athlete action object in the feature image, and U denotes the binary mask, and $U(l) = 0$ means that the corresponding athlete action is not extracted in the image and by this binary mask for action. The constraint of the overall detection process can be expressed as follows:

$$f = \sum_{t=1}^T (f_W^T + f_P^T). \quad (7)$$

According to equation (7), the setting part is combined with the original software content to complete the software module development part. By combining software and hardware, the design of the automatic detection system for training movements of gymnasts based on posture estimation is completed.

4. Experiments and Results

4.1. System Development Environment. To implement the hybrid teaching system for the aerobics class proposed in this paper, the development environment should be deployed first. The development platform of the system is built in a small-scale virtual machine cluster environment. The technical architecture of the development of the system in this paper is mainly divided into four parts: basic environment, data center, server side, and client side. Therefore, to realize the intelligent teaching system based on cloud services proposed in this paper, the following development environment needs to be completed, as shown in Table 2.

4.2. Experimental Data. The dataset used in this test is a fitness gymnastics championship dataset, and this dataset is commonly used for target recognition, joint point recognition, motion target tracking, and other tests. The total number of images in this dataset is 100,000, and the number of joint motion images is about 50,000. To enhance the relevance of this system test, the movements to be detected in this system are set as follows, and the contents of this image are detected by the system designed in the paper and the system currently used. The object target training action in the above image is set, and this action is found in the dataset using the system designed in the paper and the system currently in use, and the detection results of the two different systems are compared. Since there are too many images in the test dataset, only the detection results of the corresponding images are shown in this test, and the detection accuracy of similar actions is presented in the form of percentages, so as to improve the authenticity and reliability of the test results. In the system detection time consumption test, 500 random tests are conducted to improve the reliability of the time consumption test. The training process performance improvement curve and loss convergence are shown in Figures 5 and 6.

4.3. System Function Testing. In order to ensure that the design and development of our cloud-based aerobics class hybrid teaching system can meet the needs of users and verify that the system is achieving the expected functions, we need to conduct functional testing of the system. As the current system development is only for the PC side, so the

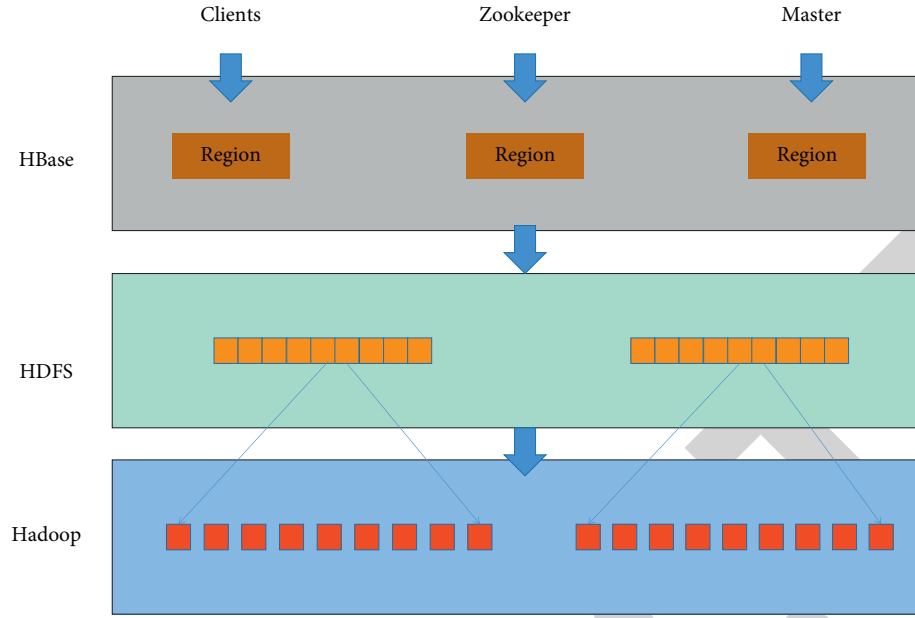


FIGURE 4: HBase system architecture.

TABLE 2: System development environment.

| Name | Illustrate |
|-------------|--|
| Windows7 | System development environment operating system |
| JDK | Required development kit for the development language Java |
| Eclipse | Development platform to realize code writing and debugging |
| NGINX | Provide load-balancing services |
| Tomcat | Provide WebServer |
| Hadoop | Provide distributed computing and storage environment |
| HBase | Basic database |
| MySQL | Extended database |
| VMware | Provide a virtual machine environment |
| vSphere SDK | Virtual environment management tool |

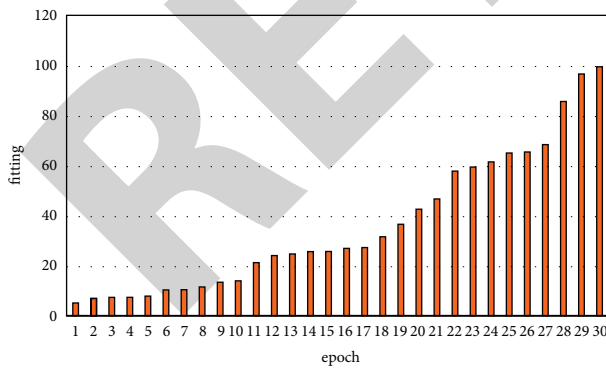


FIGURE 5: Performance improvement curve of the training process.

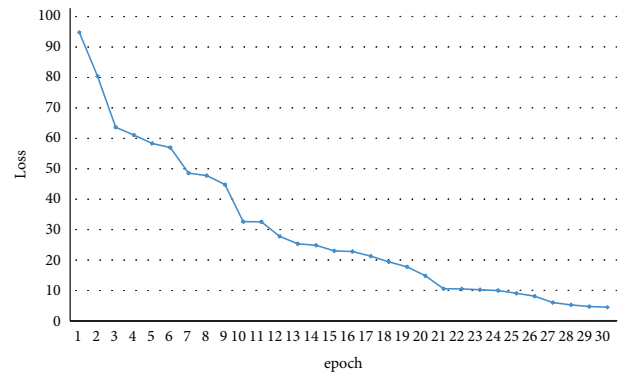


FIGURE 6: Training process loss convergence diagram.

test mainly uses the PC side for service access to the page, while testing the function, pay attention to the beauty of the page and whether the page response is adapted to the current device. Table 3 shows the detailed testing of the coarse-grained test cases for the core functions of the system.

4.4. Performance Testing. The development process of the system in this paper uses HBase, a nonrelational database for massive resource storage, which forms a high-performance cloud storage environment, and we conduct stress tests on the database below. The test results are shown in Table 4 and Figure 7.

TABLE 3: Functional testing.

| Test case number | Test items | Test content | Test results |
|------------------|---------------------|---|--------------|
| 1 | User registration | Visit the system registration page, select the user role, fill in the user information, set the password, and complete the registration | Pass |
| 2 | User login | Access the system login page, select the user role, enter the account password, and check whether you can enter the object's role space | Pass |
| 3 | Service management | Enter the system administrator space to check whether the service registration, service information configuration, service publishing, and other functions are normal | Pass |
| 4 | Resource storage | Log in to the system as a teacher or student to upload and download educational resources such as videos, documents, and audios | Pass |
| 5 | Remote classroom | Enter the system as teachers and students to complete online courses, answer questions, exams, etc. | Pass |
| 6 | Academic management | Log in to the system as an educational administrator to complete user management, review educational resources, teaching analysis, etc. | Pass |

TABLE 4: Database stress testing.

| Test metrics | Sequential write | Random read | Random write | Sequential read |
|------------------------|------------------|-------------|--------------|-----------------|
| Total elapsed time (s) | 780 | 350 | 239 | 968 |
| Speed (rows/s) | 1312 | 3242 | 1033 | 4720 |

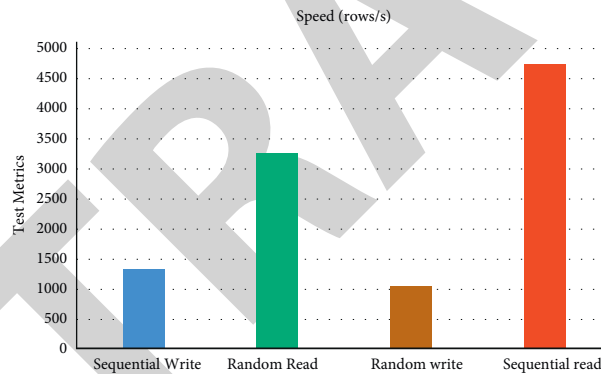


FIGURE 7: Database stress testing.

TABLE 5: Service stress testing.

| Number of clients | Service 1 read interface | Service 2 write interface | Service 1 read interface | Service 2 write interface |
|-------------------|--------------------------|---------------------------|--------------------------|---------------------------|
| 500 | 5492 | 6231 | 3560 | 3880 |
| 1000 | 5621 | 5880 | 3324 | 3560 |
| 3000 | 5122 | 5630 | 3289 | 3989 |

From Table 4, it is also necessary to test the system services, and here two services, resource management and remote classroom, are selected for stress testing. The specific test method is to select the two types of interfaces provided by the services for reading and writing and to obtain the average value of the number of outputs per minute for each service in pages/min by changing the number of clients and sending requests within one minute. The test results are shown in Table 5 and Figure 8.

By analyzing the data in Table 5, the system can still run stably and meet the basic requirements of the design in the case of high concurrency of services.

4.5. Performance Comparison. The comparison results of tracking recognition accuracy obtained by the two systems after testing a series of videos of the database for different items are shown in Table 6 and Figures 9 and 10.

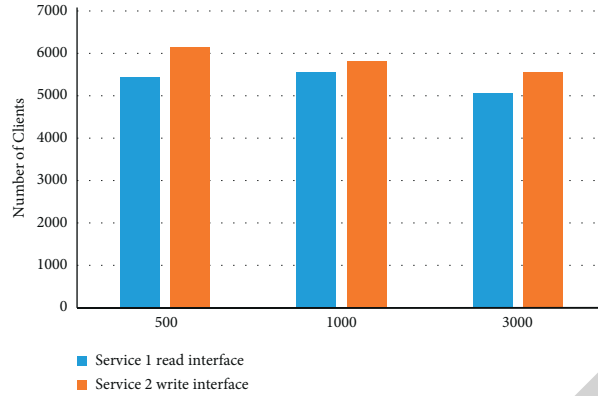


FIGURE 8: Service stress testing.

TABLE 6: Comparison of the tracking recognition accuracy of the two systems.

| Test items | Accuracy of the original system | | Accuracy rate of this system (%) |
|------------------------------|---------------------------------|------------|----------------------------------|
| | Highest (%) | Lowest (%) | |
| Iris dataset | 73.3 | 51.3 | 76.5 |
| Wine dataset | 61.5 | 58.6 | 66.4 |
| Torso and noise | 81.6 | 54.9 | 84.5 |
| Lower extremities with noise | 75.6 | 50.9 | 79.6 |

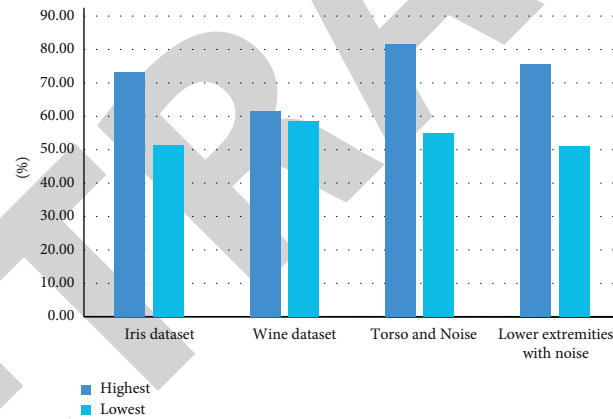


FIGURE 9: Comparison of the tracking recognition accuracy of the original system.

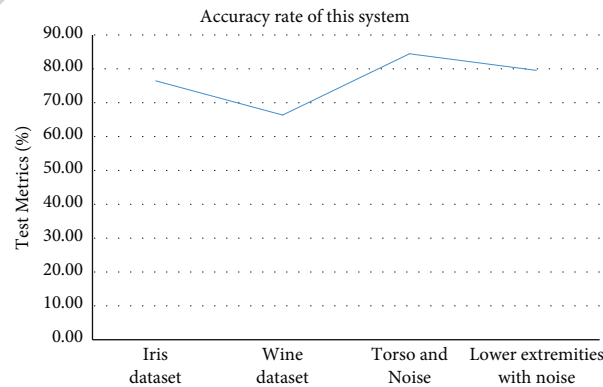


FIGURE 10: Tracking accuracy of the proposed system.

The designed system, in order to improve the tracking recognition performance in the actual application process, is tested on the same test data on the assumption that the original system has obtained the clustering a priori, and the tracking recognition results of the two systems are compared.

5. Conclusion

Under the background of “Internet+,” the deep integration of information technology and teaching, the updating of aerobic exercise teaching methods, the positive learning experience of teacher-student interaction, and practice in teaching are the core of aerobic exercise class teaching design, and the teaching focuses on the cultivation of independent learning ability, teamwork ability, practical ability, and other comprehensive abilities. Meet the personalized development of students. The hybrid teaching of aerobics classes in leisure sports combines the advantages of traditional teaching and online teaching, and the teacher-led and student-led teaching methods such as task-based, project-based, inquiry-based, discussion-based, and interactive teaching methods become the main body of aerobics teaching method. By using a cloud computing platform, the hybrid teaching design of aerobics class for leisure sports majors, through 18 weeks of hybrid teaching practice of aerobics class, using the process and summative evaluation combined, in APP, WeChat exchange group, classroom, and other comprehensive, multiangle teaching evaluation, it is concluded that hybrid teaching can improve students’ learning enthusiasm, improve teaching efficiency, and improve the teaching effect and has a facilitating effect on achieving teaching objectives. Students’ satisfaction and recognition of the effect of blended teaching in aerobics class is high, which has a positive impact on improving students’ learning attitude and motivates students to expect to use blended teaching in other physical education disciplines as well. The blended teaching of aerobics classes in leisure sports allows teachers to have more time for error correction, guidance, and communication in class and students to have more time for practice, which is more beneficial to the breakthrough of important and difficult points and the improvement of skill level. In addition, students discuss problems and submit assignments through the online platform, making teaching feedback timely and communication more convenient. In the future, we plan to carry out the design of a hybrid teaching system for aerobics classes in recreational sports using knowledge graphs.

Data Availability

The datasets used during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This work was supported by Shanxi Higher School Teaching Reform Innovation Project in 2021 (project no. J2021734).

References

- [1] B. Ji, Y. Li, D. Cao, C. Li, S. Wang, and D. Wang, “Secrecy performance analysis of UAV assisted relay transmission for cognitive network with energy harvesting,” *IEEE Transactions on Vehicular Technology*, vol. 69, no. 7, pp. 7404–7415, 2020.
- [2] X. Lin, J. Wu, S. Mumtaz, S. Garg, J. Guizani, and M. Guizani, “Blockchain-based on-demand computing resource trading in IoV-assisted smart city,” *IEEE Transactions on Emerging Topics in Computing*, vol. 9, no. 3, pp. 1373–1385, 2021.
- [3] J. Zhou, Z. Wu, J. Li et al., “Decentralized on-demand energy supply for blockchain in Internet of things: a microgrids approach,” *IEEE Transactions on Computational Social Systems*, vol. 6, no. 6, pp. 1395–1406, 2019.
- [4] C. Ma, “Design and practice of aerobics teaching design based on data fusion,” *Algorithm Wireless Communications and Mobile Computing*, vol. 2022, Article ID 1275508, 14 pages, 2022.
- [5] W. Zhu, “Research on the Blended Teaching Mode Reform of University Physical Education Curriculum Based on the Integration of 5G Cloud Computing and Multimedia,” *Mobile Information Systems*, vol. 2021, Article ID 4035878, 11 pages, 2021.
- [6] C. Chen and X. Zhu, “Application research on information security of aerobics information digital system based on Internet of things technology,” *Journal of Intelligent and Fuzzy Systems*, pp. 1–8, 2021.
- [7] A. Kyan, M. Takakura, and M. Miyagi, “Does physical fitness affect academic achievement among Japanese adolescents? A hybrid approach for decomposing within-person and between-persons effects,” *International Journal of Environmental Research and Public Health*, vol. 15, no. 9, p. 1901, 2018.
- [8] M. S. Arietaleanizbeaskoa, E. Gil Rey, N. Mendizabal Galastegui et al., “Implementing exercise in standard cancer care (bizi Orain hybrid exercise program): protocol for a randomized controlled trial,” *JMIR Research Protocols*, vol. 10, no. 8, Article ID e24835, 2021.
- [9] Q. Xia and Y. Jin, “Effects of aerobic exercise on hippocampal ERK methylation expression in aging rats at different periods [J],” *Revista Científica de la Facultad de Ciencias Veterinarias*, vol. 30, no. 2, pp. 797–805, 2020.
- [10] J. E. Pereira-Rodríguez, D. G. Peñaranda-Florez, R. Pereira-Rodríguez et al., “Comparison of the effects of aerobic and force exercise in patients with heart failure after a cardiovascular rehabilitation program: randomized controlled trial,” *Cardiovascular and Metabolic Science*, vol. 30, no. 1, pp. 14–27, 2019.
- [11] L. Banks, L. Sparrow, N. Sandison, P. Oh, and T. J. F. Colella, “The effect of insulin on post-exercise hypoglycemia in adults with type 2 diabetes participating in outpatient exercise-based cardiac rehabilitation,” *European Journal of Applied Physiology*, vol. 121, no. 12, pp. 3361–3367, 2021.
- [12] P. J. Karalekas, N. A. Tezak, E. C. Peterson, C. A. Ryan, M. P. da Silva, and R. S. Smith, “A quantum-classical cloud platform optimized for variational hybrid algorithms,” *Quantum Science and Technology*, vol. 5, no. 2, Article ID 024003, 2020.
- [13] N. Weber, D. Liou, J. Dommer et al., “Nephele: a cloud platform for simplified, standardized and reproducible microbiome data analysis,” *Bioinformatics*, vol. 34, no. 8, pp. 1411–1413, 2018.
- [14] M. Tao, Z. Zhonghong, W. Tiecheng et al., “Architecture design and implementation of E&P Dream Cloud platform,” *China Petroleum Exploration*, vol. 25, no. 5, p. 71, 2020.

Retraction

Retracted: Analysis on Organizational Structure System Model of China's Sports Management System Based on KNN Algorithm

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Ren and C. Du, "Analysis on Organizational Structure System Model of China's Sports Management System Based on KNN Algorithm," *Mobile Information Systems*, vol. 2022, Article ID 7048312, 10 pages, 2022.

Research Article

Analysis on Organizational Structure System Model of China's Sports Management System Based on KNN Algorithm

Jie Ren¹ and Congxin Du² 

¹Taiyuan Institute of Technology Department of Physical Education, Taiyuan, Shanxi 030008, China

²Wuhan Sports University Department of Physical Education, Wuhan, Hubei 430079, China

Correspondence should be addressed to Congxin Du; ducongxin@whsu.edu.cn

Received 3 June 2022; Revised 7 July 2022; Accepted 13 July 2022; Published 31 July 2022

Academic Editor: Amit Gupta

Copyright © 2022 Jie Ren and Congxin Du. 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 national sports management function requires the government to sincerely help sports associations, cultivate intermediary organizations and sports markets, and urge them to gradually realize autonomy, so as to promote the socialization of national sports. The organizational structure reform of China's sports management system needs not only a clear goal but also a new way to achieve it, so that the reform route is clear and the reform process is supported. Therefore, sports public service has entered the vision of China's leisure education reform. In this paper, KNN (K-Nearest Neighbor) algorithm is used to establish the power measurement model of organizational structure individuals, quantitatively analyze the power distribution of organizational structure, and describe the nonlinear relationship between the power distribution of organizational structure individuals and organizational hierarchy. On this basis, aiming at the shortcomings of KNN algorithm when the sample distribution is unbalanced, a penalty mechanism is added and improved. The results show that under the condition of unbalanced samples, the classification effect is obviously improved, which is about 6% compared with KNN classifier and about 3% to 4% compared with SVM (support vector machine) classifier. *Conclusion.* The improved algorithm achieves high classification accuracy on the basis of good robustness.

1. Introduction

Establishing the concept of public service-oriented government is the inevitable demand under the background of social transformation, and it is also the direction of government reform. Marketization is the core of social transformation. Marketization, industrialization, modernization, and the reform of the socialist system have influenced, infiltrated, and restricted each other, thus constituting an unprecedented, profound, and complex social change. China's sports management system has long been firmly branded with the imprint of system management in the planned economy era [1]. As an important part of China's sports system reform, China's sports management system deserves more attention. How to establish a new system in which the state and society both are in charge of sports is a major issue under the background that the national

economic system is divided from single public ownership to multiple ownerships.

Under the planned economic system, China's highly centralized sports system, which relies solely on the state and mainly on administrative means to run sports, has not changed substantially, and the contradiction between the traditional all-powerful government's administrative model and China's sports practice has intensified day by day. With the transformation of state-owned enterprises, social welfare undertakings run by units including staff sports have been stripped out of the system. This change has impacted the inherent model of China's unique unit-based staff sports and made the original staff sports management change in the system, organizational structure, operating mechanism, and group interests [2]. Chalip can reflect the development of employee sports from the research process of employee sports [3]. Jeremy pointed out that employee sports are an

important part of mass sports. From the perspective of participants, it is mainly the employees of factories, mines, enterprises, institutions, and other units. It is a sports activity that takes fitness and entertainment as its main purpose and is carried out according to the principle of spare time, voluntariness, flexibility, and diversity [4]. Zhang comprehensively investigated the influence of the social environment on sports development in the 21st century from the perspective of sociology, economics, and other disciplines [5]. Fanjul-Suarez and others attribute the motivation of sports management system reform to the role of two trends. The first trend is the development of market economy and the corresponding unstoppable change in the economic system. The second trend is the development of world sports and its own restless reform tendency [6].

People's diverse understanding of sports is not only reflected in participation but also creation. The most prominent feature of the combination of sports and leisure lies in constant innovation. People constantly use novel and unique ways to explain the relationship between man and nature, man and society, man and himself, and confirm the power as the main body. In modern society, the power in sports is usually owned by the government or social sports organizations, or shared by them [7, 8]. According to the relevant theories and methods of public service, we can reinterpret and explain the important challenges faced by China's sports management system. On this basis, drawing lessons from foreign experience and combining with China's historical experience, taking industrial economics, new institutional economics, management science, and regulatory economics as the theoretical basis, KNN (K-Nearest Neighbor) algorithm is used to establish the goal, content, and implementation measures of China's sports management system reform, which provides historical reference, realistic reference, and theoretical basis for China's sports management system reform.

2. Related Work

2.1. Research on the Sports Management System. China's sports management system refers to the sum total of relatively stable systems and systems formed by the organization setup, authority division, and operation mechanism of competitive sports management. A suitable sports management system and operation mechanism in China is the cornerstone of the development of sports in a country. At present, although there are a lot of domestic research on China's sports management system and operation mechanism, there are relatively few research results with high application value, especially the successful experience of China's foreign sports management system and operation mechanism lacks systematic and in-depth combing and refining.

Zeng pointed out that adhering to the national system of competitive sports requires a new understanding of some important issues, and studied the problems existing in the operation of the national system and suggestions for improvement [9]. Gimeno and Paris put forward to reconstruct a competitive sports development model that not only

conforms to the current social reality of our country but also converges with the development direction of our social reform [10]. Hoogendoorn et al. pointed out that the American government's involvement in competitive sports is very limited. In the United States, sports organizations such as the U.S. Olympic Committee and the National Collegiate Sports Association are mainly responsible for managing competitive sports affairs [11]. Olusaga et al. pointed out that there are some problems in the American-Chinese sports management system, such as gender inequality, racial inequality, excessive pursuit of competition results, and commercial interests, which affect the all-round development of American competitive sports and violate the sportsmanship to some extent [12]. Park and Maher put forward that the collision of dominant cultures and the gradual establishment of a market economic system in the process of the integration of Chinese and American sports cultures will contribute to the reconstruction of the Chinese nation's cohesive value system [13].

Bari analyzed and discussed the basic organizational structure of the national fitness system, the requirements of social changes in the management of community sports organizations, the current problems in the management of community sports organizations, the integration of countermeasures of community sports organizations, and the management network of community sports organizations [14]. Yang et al. described the development track of modern sports in the evolution of China's social structure, discussed the influence of modern society on sports development, and the position and role of sports in modern social life, and put forward the future direction of sports development in China, so as to form a benign interactive relationship between sports and social development [15].

2.2. Research Status of KNN Algorithm. KNN is a widely used classification algorithm. It finds out the K neighbors (documents) closest to the documents to be classified from the training set, and determines the categories of the documents to be classified according to the categories of these K neighbors. The main idea is to classify the query samples by the distance between the local mean vectors of K neighbors in each class and the samples to be tested. The classification performance is excellent in data sets with outliers and imbalances.

Pan et al. put forward a selective nearest-neighbor classification algorithm based on naive Bayes. The experimental results show that the classification accuracy is higher than that of traditional naive Bayes classification and DT (Decision tree) C4.5 classification algorithm [16]. Lee et al. put forward the method of generating weights based on gradient descent to integrate the distances between attributes. Compared with other distance measures, this method has better adaptability to small-scale and unevenly distributed data sets [17]. Berrett et al. put forward a new index structure model, effectively implemented KNN query algorithm, solved K nearest-neighbor query problem in the spatial network database, and realized real incremental output [18].

Cai et al. proposed a KNN classification algorithm based on double-weighted voting rules. The algorithm established double-weighted voting functions according to the distance and rank of KNN, and used this rule to vote, which effectively overcome the sensitivity problem of neighborhood size K selection in KNN rules and improved the classification performance of the algorithm [19]. Carine et al. put forward a KNN algorithm based on sparse learning. By reconstructing the test samples, the optimal K value of each sample to be tested is obtained, which overcomes the shortcoming of the previous KNN algorithm that the K value of each test sample is fixed [20].

3. Research Method

3.1. Analysis of the Reorganization of the Organizational Structure of the Sports Management System. In modern society, due to the expansion of the scale of various activities, the increasingly complex relationship with the environment, and the need for more complex collaborative work and labor to accomplish the goals, the role of the organization is increasingly huge and irreplaceable. The structure is an important part of an organization and an important means of its operation. The organization involves the specific division of labor and functions of various components and personnel within the organization. It determines the integrity of the organization system, the crisscross power and responsibility relationship among various institutions and personnel, and the specific methods of work division, coordination, and communication.

The traditional management mode is coming to an end, and the new era brings new ways of competition; the new era calls for new organizational forms and new management methods. Complexity science is introduced to accomplish the task of complex management. Especially, we are deeply rethinking the organizational form and management mode, and how to consider the organizational management of sports system structure from a new angle under the guidance of new theories. From the analysis of technical factors only, the organizational management model of the system is as follows:

$$E_T = M \times K \times \min J, \quad (1)$$

where E_T is the system function; M is the total number of units in the system (complex multilevel system); K is the multiplier of system function misfortunes; and $\min J$ is the minimum value of simplicity or technical level of all unit elements when system function misfortunes.

People give less weight to their efforts at work due to a small amount of incentive investment, and they do not care much about how this small amount of incentive investment is distributed between individuals and associations, and how much benefits they can get from this small amount of incentive. And the incentive substitution rate must be equal to the economic substitution rate. Otherwise, it means that the incentive utility obtained when the system is invested in a certain incentive mode can be obtained by another incentive mode at a lower cost. For example,

$$\frac{\omega^i}{\omega^j} = \frac{2}{l} \neq \frac{l}{1} = \frac{\partial u(x^*, m^*) / \partial m^i}{\partial u(x^*, m^*) / \partial m^j}. \quad (2)$$

We can get the same incentive effect by using one less incentive input m^i and one more incentive input m^j , but the cost is reduced because we use the price of 2 units for the i incentive investment and the price of l units for the j incentive investment.

The vertical multilevel differentiation of the national sports management system is differentiated according to the different tasks undertaken by different management organizations and grades. Its differentiation is characterized by adapting to the diversification of the market economic system and establishing a transitional organization that gradually simplifies administration and decentralizes power, and strengthening macrocontrol to promote sports socialization. The pyramid structure of China's sports management organization is designed by using the people-oriented principle of modern management, as shown in Figure 1.

Certainly, this management system can play a positive role in the early stage of economic system differentiation. However, from the analysis of the situation of actively adapting to the development of the market economy, it is easy to overlap functions and needs a long running-in period because of its multiple management levels. Therefore, the main reason for the above-mentioned problems in China's sports system, in reality, is that the reform is still incomplete, and the management system and operation mechanism that are compatible with the socialist market economic system have not been established. Therefore, it is necessary to deepen the reform of the national sports management system.

The organization is the core of the management system and the material basis for achieving management objectives. To realize the goal of the sports management system, it is necessary to set up a reasonable sports industry management organization. The current management system of China's sports industry is unreasonable in institutional setup. The sports industry management office under the Economic Department is not closely connected with local sports industry management organizations. In the general government management system, the central and local sports industry management institutions are also confused, and there is no uniform standard and institutional setting. In addition, in the aspect of the social general management system, the number and management ability of sports nongovernmental organizations and sports intermediary organizations are very limited, so it is difficult to effectively play their management functions.

We can understand the way of performing administrative functions as various means, methods, and technologies applied by public institutions such as government departments in the process of providing public services and meeting people's needs. There are different ways to perform government functions. This paper mainly divides them from the perspective of whether the government intervenes or not, as shown in Figure 2.

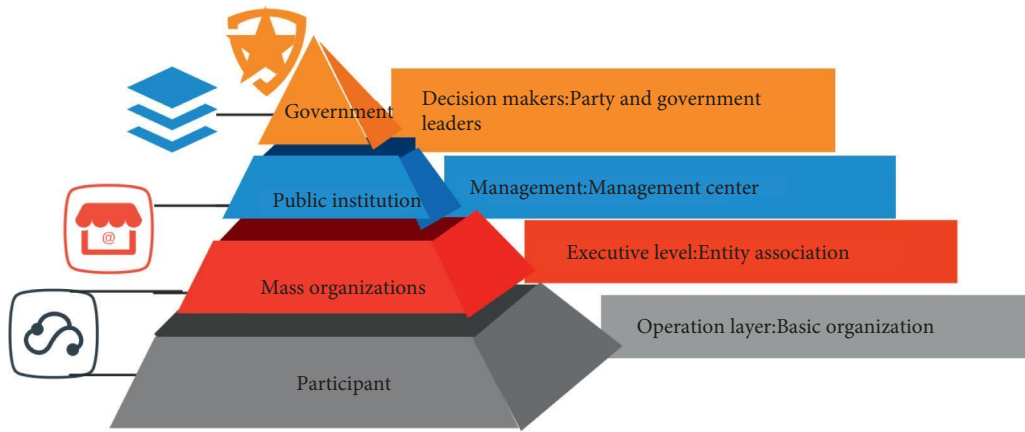


FIGURE 1: Schematic diagram of the sports management organization structure.

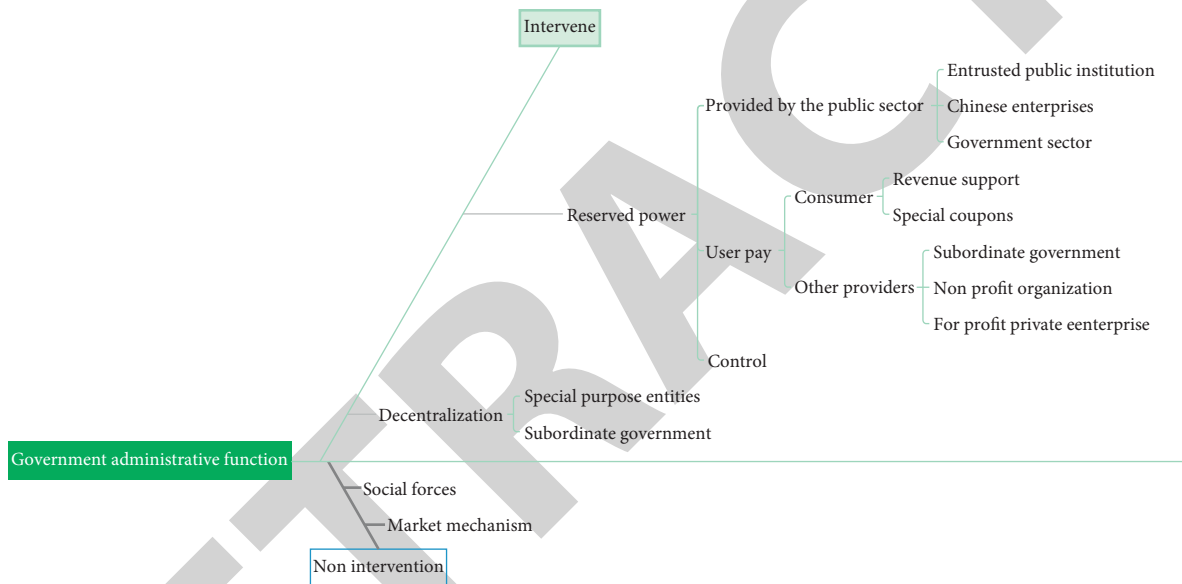


FIGURE 2: Ways of performing government administrative functions.

On the basis of understanding the respective functions of different ways of performing sports administrative functions, it is necessary to determine some specific standards when defining and choosing them. This is because sports administrative departments need a conceptual framework and a critical thinking process to consider the criteria and possible risks that can achieve the best-balanced choice. If a public action fails to achieve its intended purpose, even if the cost paid is small, this public action is meaningless. According to the efficiency standard, the best way to perform sports administrative functions is to achieve the best balance between income and cost. However, the cost of implementing sports administrative functions includes not only the direct cost of the government, that is, the cost of completing the public action by the government, but also the price that its action object needs to pay for receiving sports public services.

Most sports events in China are directly managed by the sports center. The management system of sports is an organizational means to adapt to its management functions,

institutional setup, division of authority, and adequate protection of people, money, and things. It is made up of business offices, sports teams, relevant departments of various provinces and cities, and sports management departments from bureaus to departments, which are responsible for the specific implementation of some policies and the development of regional competitive sports. China's provincial and municipal sports bureaus are the local government departments in charge of the city's sports work, performing their respective main functions. From the perspective of culture, China's competitive sports system just reflects this trait of Chinese culture and the value orientation shown by this trait.

3.2. Construction of the Organizational Structure System Model of the Sports Management System. The typical feature of China's sports management system is that the government exercises the management power, the state undertakes most of the economic obligations, and the management means are

mainly administrative means. The advantage of this management system is that it is convenient to effectively integrate and optimize sports resources, so as to achieve the goal of achieving excellent results in major international sports events such as the Olympic Games. From the perspective of the internal setup of sports institutions, all sports administrative departments at or above the provincial level in our country have institutions specifically responsible for competitive sports. There is a typical administrative subordination relationship among the management bodies of competitive sports in China, and the status of each management body is unequal. All forces should be mobilized through the administrative system and administrative orders to jointly promote the development of competitive sports in China.

In the process of the reform of China's sports administrative management system, strengthening the performance evaluation of sports public service is conducive to changing the evaluation mode of public service from abstract organizational performance to concrete public service effect, and from internal orientation to external perspective, so as to put efficiency under the framework of publicity. At the same time, combined with the reform of sports institutions in China, the relevant departments should also consider the internal organizational setup of institutions and external public output, such as considering the degree of conflict of the same level or cross-power within institutions and whether the type of departmental power meets the needs of providing high-quality and efficient services. Moreover, the results of performance evaluation of sports public service are also helpful to realize the optimization of sports administrative power mechanism in China, reshape the role of the government, and thus promote the rational positioning of government sports administrative functions.

The quality of network structure is a measure of the accuracy of information circulating in the network organization, and the quality entropy describes the uncertainty of information quality. The larger the network organization, the greater the number of nodes, and the greater the possibility of error. The order degree of network structure based on the aging quality model, which comprehensively considers the aging and quality of information transmission, is expressed as

$$R = \alpha R_1 + \beta R_2, \quad (3)$$

where R_1, R_2 indicate the timeliness and quality of information transmission, respectively, and α, β represent the weight coefficients of information timeliness and quality in the network organizational structure.

But when we study the organizational structure, we pay more attention to the relative proportional relationship between individual $P(i, j, k)$ power and other individual powers, and the relative power of the individual $P(i, j, k)$ is expressed as

$$Q(i, j, k) = \frac{A(i, j, k)}{\sum_{i=1} A(i, j, k)}. \quad (4)$$

If the standard relative power of any organizational structure is defined as 50, the relative power of the individual $P(i, j, k)$ is standardized, and the obtained power is called standard relative power, which is expressed as $E(i, j, k) = 50Q(i, j, k)$.

On this basis, the organizational system $S = d_1, \dots, d_N$ is an N -dimensional vector composed of decision variables, and its overall fitness can be expressed by the formula:

$$\Omega = \frac{1}{N} \sum_{i=1}^N w_i (d_i; D_i). \quad (5)$$

The formula D_i represents the set of K decisions that affect the decision d_i , and the contribution of a decision variable to organizational performance depends not only on its state but also on the state of other K decision variables associated with it.

The basic idea of KNN algorithm is easy to understand. To determine the category attribute of a test text, we must first compare this text with a group of texts with clear category attributes, find out the K texts with the greatest similarity, and then determine the category of this document through certain selection rules among these K adjacent texts.

Let there be two points $x = (x_1, \dots, x_n)$, $y = (y_1, \dots, y_n)$ in the n -dimensional space, then the cosine similarity formula between them is defined as follows:

$$\cos(x, y) = \frac{x \cdot y}{\|x\| \cdot \|y\|}. \quad (6)$$

The closer the cosine value is to 1, the smaller the difference between individuals, and the closer it is to 0, the greater the difference between individuals.

The distribution imbalance that this paper tries to show refers to a relative imbalance between data. Here, a new parameter, coefficient of variation, is introduced, which can reflect the imbalance between data of different averages. Divide the standard deviation by the average value to get the desired mathematical variable, that is, the expression

$$\frac{\sqrt{\left[\sum_{j=1}^m (p_{ij} - \bar{p}_i)^2 / 2 \right]}}{\left[\sum_{j=1}^m p_{ij} \right] / n}. \quad (7)$$

In the classification of sample sets, the n values of the two groups of data sets compared are the same, and the n values can meet each other. Through the relevant results of the follow-up experiments, it can be found that if the above-mentioned parameter variables are directly introduced into the traditional weight formula, the weight calculation will rely too much on this parameter, which will affect the classification results.

The uniformity of text distribution in each category in the sample set has a certain influence on text classification. The uniformity of sample sets is related to the calculation of feature selection weight and classification. The classification effect of general classification systems on uniformly distributed sample sets is obviously better than that on unevenly distributed sample sets. Therefore, the selection of the sample set is also very important for the text classification

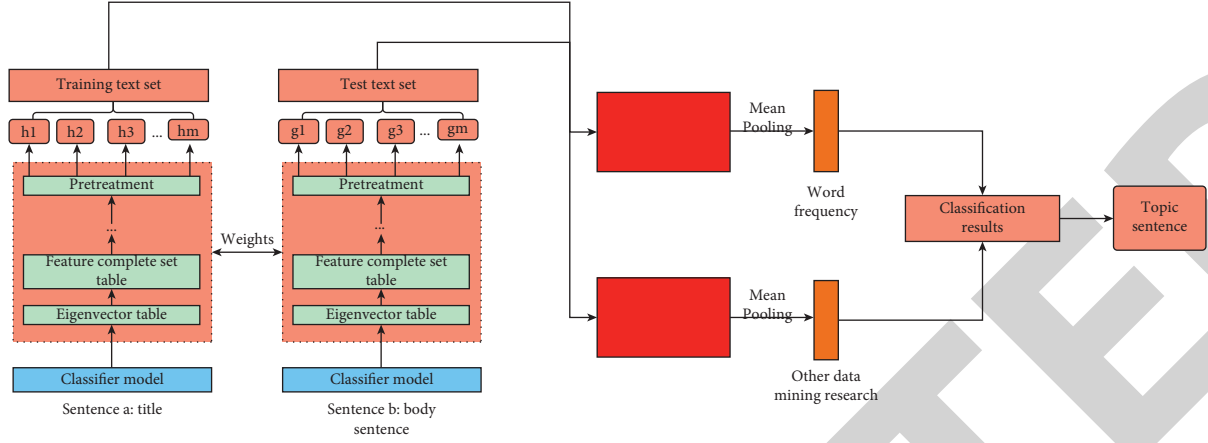


FIGURE 3: Logical model of the classification system.

system. The logical model of text classification adopted in this design system is shown in Figure 3.

The main feature is that the coupling between modules can be loosened, and the intermediate results of each module can be conveniently obtained. It can freely add new modules and algorithms or improve existing modules without any influence on other modules. In this way, it is convenient to compare and study various algorithms of each module.

The standard KNN algorithm has many performance problems. For example, when there are a large number of samples, the calculation will become quite slow, so the performance cannot meet our requirements. For some special applications, if there is a different embodiment in quality, it is far from meeting our requirements.

In order to solve the problem that the classification effect decreases when the data distribution of the training sample set is unbalanced, this paper adopts the method of improving the algorithm and adds a simple punishment mechanism to KNN algorithm to form the improved KNN algorithm. By using the related parameters of the ratio of the number of positive and negative categories and weighting the traditional vector distance calculation formula, we can compensate the category with a small number of samples and punish the category with a large number of samples. The improved vector distance formula used in the algorithm is shown in the following formulas:

$$d(x, x_i^+) = C + \|\varphi(x) - \varphi(x_i^+)\|$$

$$= \frac{m}{m+n} \sqrt{k(x, x) - 2k(x, x_i^+) + k(x_i^+, x_i^+)} \quad (8)$$

$$d(x, x_i^-) = C - \|\varphi(x) - \varphi(x_i^-)\|$$

$$= \frac{m}{m+n} \sqrt{k(x, x) - 2k(x, x_i^-) + k(x_i^-, x_i^-)} \quad (9)$$

In this paper, most of the improved algorithms are basically unchanged, only the part where the algorithm calculates the distance between each support vector in the support vector set and the test text is modified, and the penalty compensation mechanism is used. The specific steps are shown in Figure 4.

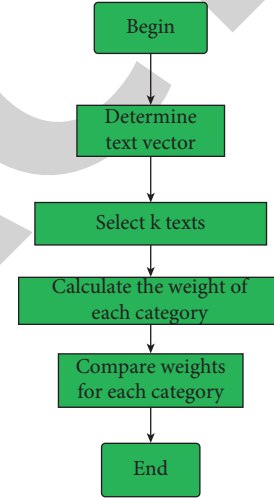


FIGURE 4: Flow chart of improved KNN algorithm.

When large-scale text classification is carried out, it often takes a high time complexity to adopt a complete traversal method. Therefore, some scholars put forward some methods to speed up the search, such as constructing an index table and reducing the search scope.

Combining with SVM (support vector machine), Bayes, and other classification algorithms, a hybrid classification algorithm is obtained, which complements their respective shortcomings, thus making up for the defect that KNN cannot get the model. Then, classified according to the traditional KNN algorithm steps, and when calculating the similarity of classes, the exclusive K value is selected so as to get the category of new text.

4. Result Analysis

It is unimaginable that the matrix operation in the standard KNN algorithm takes a lot of time. In order to increase the closeness of the connection between things, we must increase the dimension, and the cost of increasing the dimension obviously increases the overhead of the program. The correctly classified samples remain unchanged.

TABLE 1: Improved time results.

| Matrix dimension | Operation time (s) |
|------------------|--------------------|
| 64 | 0.00086 |
| 128 | 0.0013 |
| 256 | 0.0062 |
| 512 | 0.0214 |
| 1024 | 0.1629 |

Experimental results show that the classification effect of KNN classifier adjusted by this algorithm is significantly improved. Let us now multiply 100 vectors by pairs. In order to get the distance between every two numbers, there are 4,850 combinations of two numbers randomly selected from 100 groups of vectors. Through the operation, we find the results as shown in Table 1.

It can be seen that with the increase in dimensions, the time spent by GPU is also increasing, but compared with the time spent by CPU, this time is very small and can be completely ignored.

The traditional method of processing information in a text database is information retrieval technology, and a typical information retrieval mechanism is to locate related documents according to keywords input by users. There is often only a small amount of text information in the retrieval results that users need. In order to query accurately, it is necessary to increase the number of keywords, but this requires users to know the contents of documents. Therefore, in order to process a large amount of text data more effectively, text mining technology has been developed in depth.

According to the class labels of K neighboring samples, the local mean values of all kinds of neighboring samples are calculated. Finally, the distance between the sample to be measured and various local mean vectors and the class contribution rate are used to divide the sample to be measured. Statistics of specific classification results are shown in Figures 5 and 6.

It can be seen that the accuracy rate based on the improved KNN algorithm is slightly higher than that of the traditional KNN algorithm, but there are also some categories that decline. Generally speaking, it is slightly better than the traditional KNN classification algorithm. It may be related to the size of the sample set because the number of samples is not large enough. This method is sensitive to context and is a selective conceptual abstraction.

Used in text classification, only the information that is useful for text classification is extracted. It extracts phrases, texts around phrases, and potential semantic information, and determines text categories. This is reasonable and necessary for documents whose categories do not match the predefined categories. If this happens frequently, it means that the predefined categories need to be modified, and then the above training and classification process should be repeated.

By using the local mean of K neighbors in their respective class sets, the distribution of each neighbor in its respective class is captured to the greatest extent. By calculating the weighted distance between the sample to be tested and the local mean of each class, the class attributes of

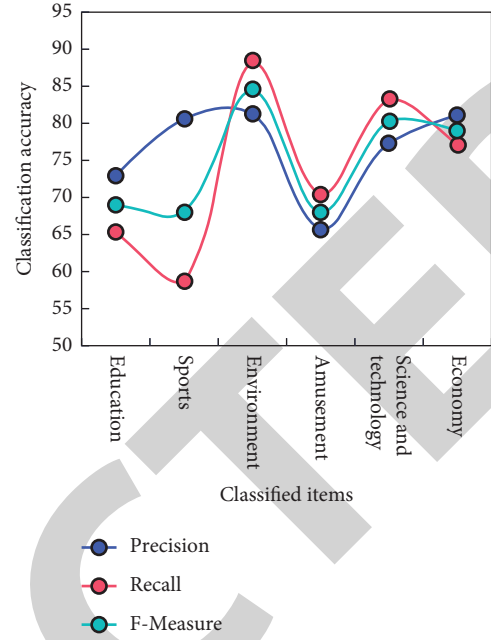


FIGURE 5: Traditional KNN classification results.

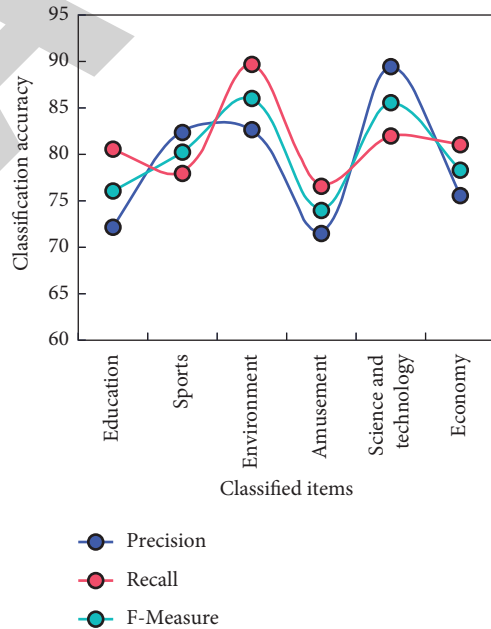


FIGURE 6: Improved KNN classification results.

the sample to be tested are accurately captured and the sensitivity of K value is effectively overcome.

The improved algorithm is verified by tenfold cross-validation. Results take the average of 10 correct rate results. Figure 7 shows the test results on the data set using KNN and the improved algorithm.

The test results show that compared with the original KNN algorithm, the improved KNN algorithm based on mutual information and local mean has the biggest difference in accuracy on data sets, with a difference of 13.12%. Weighting the attributes based on the correlation of mutual information and dividing the adjacent samples by the

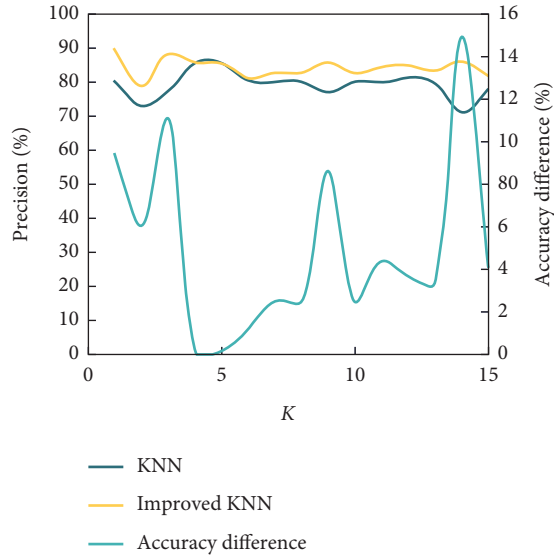


FIGURE 7: Comparison of the accuracy of the algorithm under different K values.

comprehensive distribution principle can effectively improve the accuracy of KNN. When $K = 14$, the accuracy difference between the two algorithms is the largest, reaching 14.99%. The average accuracy of all K values is 4.31% higher than that of the original KNN.

The corresponding semantic analysis program is responsible for the formation of semantic analysis results. What semantic information needs to be recorded in the thesaurus and their expressions are determined according to the needs of semantic analysis programs. Because the final result of the semantic word segmentation method includes the internal representation of the analysis result, it provides a high starting point for subsequent processing. All the features in a text constitute the whole semantics of the text, and the correlation and co-occurrence of features are significant for the similarity of texts. However, the calculation of similarity in the traditional vector space model does not take into account the correlation and co-occurrence of feature words, which makes the classification result unsatisfactory.

Three algorithms are compared on 12 standard data sets. In the experiment, the parameter K is optimized by cross-validation. Figure 8 shows the average accuracy of the three algorithms under the optimal K value and the confidence interval of the accuracy under 95% confidence level.

It can be seen that the accuracy of this algorithm is superior to other algorithms on almost all data sets, and the corresponding standard deviation is almost the smallest. Compared with ref [16] algorithm, the accuracy of the algorithm is improved by nearly 3~4 percentage points on 1~3 data sets. On data set 6, the accuracy rate is as high as 100%. In some datasets, the accuracy of DT algorithm is slightly different from that of this chapter, but there is a significant difference between standard deviations, which means that the proposed method is more stable to some extent. However, compared with other comparison algorithms, this algorithm has high accuracy and good robustness.

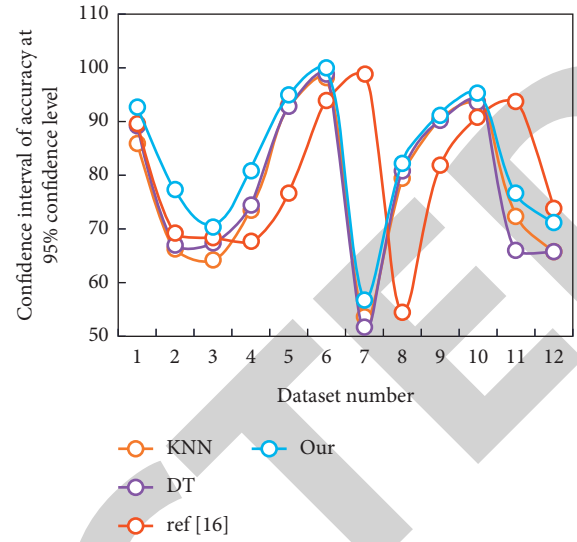


FIGURE 8: Confidence interval of accuracy at 95% confidence level.

In order to analyse the differences of the results in two different environments between feature selection algorithm and improved classification algorithm, balanced sample set and unbalanced sample set are used; the results of the macro recall rate, accuracy rate, F1 value, micro recall rate, and accuracy rate are shown in Table 2 and Figure 9.

It can be seen that under the condition of unbalanced samples, the classification effect is improved obviously, about 6% compared with the KNN classifier and about 3% to 4% compared with the SVM classifier. In addition, by observing the classification results of different classes, it can be seen that when the sample set is balanced, the classification results of various classes are relatively uniform, and the recall rate and accuracy rate do not fluctuate much; when the sample set is unbalanced, the classification results of various classes fluctuate greatly, among which the class with a small number of samples has higher accuracy rate and the class with a large number of samples has higher recall rate.

At present, China has not yet formed standards for conformity assessment activities such as stadium inspection and sports facilities inspection; the evaluation procedure of sports service conformity has not yet formed a new situation of organic combination and mutual supplement; and constructing the organization and management system of China's sports industry service conformity assessment, which is composed of the administrative layer, the expert technical management layer, the working organization layer, and the working object layer of the State Sports General Administration, will help maintain the international environment of China's sports industry market operation and enhance the international level of sports industry development. Therefore, the sports industry has actually become a typical weak industry in developing countries. It is almost impossible to make the sports industry develop rapidly and participate in international competition without the strong support of national industrial policies.

TABLE 2: Classification effect of unbalanced samples.

| Index | KNN | SVM | Methods of this paper |
|----------------|--------|--------|-----------------------|
| Macro recall | 0.7332 | 0.7968 | 0.8225 |
| Macro accuracy | 0.7862 | 0.8633 | 0.8963 |
| Macro F1 | 0.7621 | 0.8021 | 0.8517 |
| Micro recall | 0.7211 | 0.7714 | 0.8546 |
| Micro accuracy | 0.7538 | 0.7906 | 0.8633 |
| Micro F1 | 0.7332 | 0.7938 | 0.8415 |

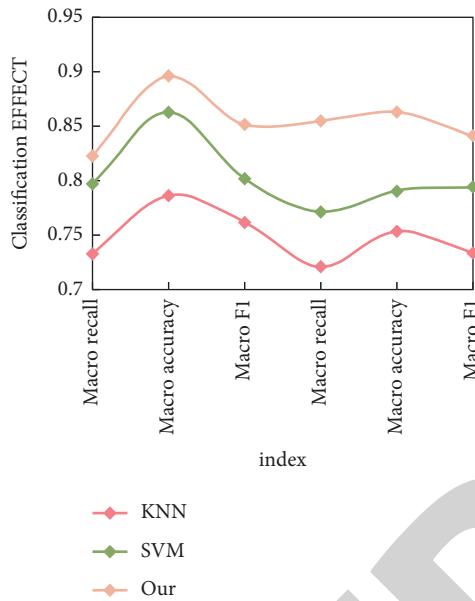


FIGURE 9: Classification effect curve.

5. Conclusion

In the reform of the national sports management system, it is necessary to reform the vertical division of labor organization structure with single nature and overlapping functions in the past, and establish a horizontal division of labor organization structure with Chinese characteristics, international common rules, diversified nature, and equal status that meets the needs of market economy system. Applying the KNN algorithm to the organizational structure system model of China's sports management system is of great significance to the scale of network organization complexity measurement. Design rule is a centralized abstraction of the complex relationship structure that restricts the adaptive process of the organization, which makes modular organizational structure have considerable advantages in the dynamic ability of dealing with complex problems. This paper analyzes the shortcomings of KNN algorithm in the case of unbalanced sample data sets and improves the algorithm for this shortcoming. The experimental results show that the accuracy of the algorithm is improved, and it is not easily affected by unbalanced data and outliers.

Data Availability

Data are available on request from the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This work was supported by the Taiyuan Institute of Technology Scientific Research Initial Funding "A Study on Corporate Brand Equity, Brand Evaluation, and Brand Effect According to e-Sports Title Sponsorship" (2022KJ090).

References

- [1] A. Donaldson, D. Borys, and C. F. Finch, "Understanding safety management system applicability in community sport," *Safety Science*, vol. 60, no. 10, pp. 95–104, 2013.
- [2] J. Pang, X. Li, and X. Zhang, "RETRACTED ARTICLE: Coastline land use planning and big data health sports management based on virtual reality technology," *Arabian Journal of Geosciences*, vol. 14, no. 12, pp. 1080–1115, 2021.
- [3] L. Chalip, "Toward a distinctive sport management discipline," *Journal of Sport Management*, vol. 20, no. 1, pp. 1–21, 2006.
- [4] S. J. Jeremy, "Sport management digest may 2013," *Journal of Sport Management*, vol. 27, no. 3, pp. 263–265, 2013.
- [5] R. Zhang, "The generalized dice similarity measures for evaluating the development level of the mass sports culture organization with 2-tuple linguistic information," *Journal of Intelligent and Fuzzy Systems*, vol. 37, no. 2, pp. 1843–1854, 2019.
- [6] A. M. Magaz-Gonzalez and J. L. Fanjul-Suarez, "Sport events organization and project management: factors, phases, areas," *Revista Internacional de Medicina y Ciencias de la Actividad Fisica y del Deporte*, vol. 12, no. 45, pp. 138–169, 2012.
- [7] D. Shilbury and L. Ferkins, "Exploring the utility of collaborative governance in a national sport organization," *Journal of Sport Management*, vol. 29, no. 4, pp. 380–397, 2015.
- [8] J. C. Smith, "Organization of a college baseball tournament," *IMA Journal of Management Mathematics*, vol. 20, no. 2, pp. 213–232, 2008.
- [9] Z. Zeng, "RETRACTED ARTICLE: The impact of vegetation change and climate in coastal cities on public sports: the impact of urban heat island," *Arabian Journal of Geosciences*, vol. 14, no. 10, pp. 901–918, 2021.
- [10] F. Gimeno and F. Paris, "Measurement of variables involved in the design of a training study: Practical experience undertaken in a sports Organisation," *Quality and Quantity*, vol. 42, no. 2, pp. 235–256, 2008.
- [11] M. Hoogendoorn, C. M. Jonker, S. Konur et al., "Formal analysis of empirical traces in incident management-ScienceDirect," *Reliability Engineering & System Safety*, vol. 93, no. 10, pp. 1422–1433, 2008.
- [12] P. Olusoga, J. Butt, K. Hays, and I. Maynard, "Stress in elite sports Coaching: Identifying Stressors," *Journal of Applied Sport Psychology*, vol. 21, no. 4, pp. 442–459, 2009.
- [13] S. Park and C. S. Maher, "Government Financial management and the Coronavirus Pandemic: a Comparative Look at South Korea and the United States," *The American Review of Public Administration*, vol. 50, no. 6–7, pp. 590–597, 2020.
- [14] M. S. Bari, "The benefit of management information system new E-government architecture in Bangladesh," *Development Policy Review*, vol. 2, no. 1, pp. 48–57, 2021.
- [15] H. Yang, Y. Hu, H. Qiao, S. Wang, and F. Jiang, "Conflicts between business and government in bike sharing system,"

Retraction

Retracted: Coordinated Development of Smart City and Regional Industrial Economy under the Background of Internet of Things

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Chen, "Coordinated Development of Smart City and Regional Industrial Economy under the Background of Internet of Things," *Mobile Information Systems*, vol. 2022, Article ID 6986090, 8 pages, 2022.

Research Article

Coordinated Development of Smart City and Regional Industrial Economy under the Background of Internet of Things

Liping Chen 

School of Finance, Jiangsu Vocational College of Finance and Economics, Huaian 223300, China

Correspondence should be addressed to Liping Chen; chenliping_vip@outlook.com

Received 12 May 2022; Revised 16 June 2022; Accepted 22 June 2022; Published 31 July 2022

Academic Editor: Amit Gupta

Copyright © 2022 Liping Chen. 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 development of wireless communication and the Internet of Things has promoted the construction of smart cities and is the technical basis for the construction of smart cities. The influence of regional economic development level on smart city construction cannot be ignored, and it constitutes the external environment of smart city construction. The combination of the two will play a driving role in the construction of smart cities. Therefore, the planning and construction of smart cities must be coordinated with the realization of the two. This paper adopts a combination of literature analysis and field investigation to analyze the decoupling between smart city construction and regional economic development, conduct research on relevant cities, and combine the current situation of smart city construction to collect the problems encountered in smart city construction and regional economic development. Through analysis, it provides suggestions for the development of smart cities and regional economic development. The survey results show that in the process of smart city construction and regional industrial economic development in the context of the Internet of Things, information security and lack of talent are the most prominent problems. Among the relevant suggestions on these issues, the proportion of talent introduction is about 45%, and the proportion of rational planning of industrial structure is about 28%. Based on the experience of existing research results, this study uses optimization algorithms to make the impact of various factors more specific, which is helpful for each region to make scientific planning based on its own actual situation.

1. Introduction

The development of IoT technology has brought great changes to people's way of life and social development. Smart city construction has become an important concept of urban development [1, 2]. In the process of exploration, scholars put forward the concept of smart city development based on innovation and green, in order to improve the sustainable development ability of the city [3, 4]. The current smart city construction process is mainly divided into the following nodes: some problems are analyzed in the current urban economic and social development [5, 6], further, the work of the highest technical level needs is designed to strengthen scientific and technological innovation, the five mechanisms are improved, and the corresponding service platform is established [7–10]. How to carry out follow-up services to ensure the sustainability of smart city construction [11–15].

In the research of smart city construction and regional industrial economic development under the background of wireless communication and Internet of Things, many scholars' discussions are very constructive. For example, some scholars pointed out that the relationship between IoT and smart city is not one-way, but highly interactive [16–18]. Some experts emphasize the relationship between different systems in a city. The interconnection between them facilitates better data exchange and exchange between heterogeneous agents [19, 20]. In Ellen Klein G's research on smart sensors, it is mentioned that smart sensors participate in the monitoring of citizens, which will help decision-making, improve the legitimacy and quality of decision-making, and achieve better results in terms of environmental quality [21]. It can be seen that foreign scholars have conducted research on the methods and approaches of smart city construction. Chinese scholars also highly affirmed the interaction

between the Internet of Things and smart cities [22–25]. In the macro field, the state has formulated the “New Smart City Evaluation Indicators (2016)”, and a large number of regions across the country have participated in the indicator evaluation [26]. Until 2019, according to the original evaluation system, it was revised to “New Smart City Evaluation Indicators (2018)”, pointing out that the smart city is the concentrated embodiment of the Internet of Things in the field of social development, and it is also an important test of the comprehensive development level of the Internet of Things technology [27]. In turn, the development of smart cities will inevitably generate new demands due to the integration of multiple fields [22]. This is also the development direction of the practical application of IoT technology [28–30]. Some researchers also suggest that the development of smart cities in China should not be rushed. After all, IoT technology is still far from cities [31–36]. Some have put forward suggestions for current local problems, such as the “information island” phenomenon proposed by Guo, and the “information resource” waste problem proposed by Wang et al. [37–39], all of which constitute a serious obstacle to the construction and development of smart cities in my country [40–42].

Taking the important foothold of smart city construction as the research object, this paper makes an in-depth analysis of the current decoupling between smart city construction and regional economic development through a combination of literature analysis and field investigation. The actual construction capacity of the project puts forward certain forward-looking development suggestions. The survey also uses the smart city entropy evaluation algorithm to process the economic data of the smart city to improve the accuracy of the evaluation [43, 44]. The advantage of the method in this paper is that the efficiency and accuracy of data processing are improved through the entropy evaluation algorithm, thereby effectively solving the problem of excessive data volume in smart cities.

2. Research Content and Methods

2.1. Research Content

2.1.1. Research Content and Objectives. The development of information technology has brought new ideas to urban development. The Internet of Things system was created with the help of information technology. It can greatly realize information sharing and improve the government's overall work efficiency and service functions. The main content of this research is how to better promote the construction of smart cities and even the development of regional industrial economy in the context of wireless communication and the Internet of Things. In recent years, the construction of smart cities has been frequently launched in various parts of our country. Some cities really combine their own needs to facilitate service work and people's lives, while some cities have no name and waste funds. How to evaluate the results of smart city construction more scientifically and accurately, and how to use the construction of anticipation models to make the construction of smart cities

have clearer goals, thereby reducing unnecessary economic losses, is the main goal of this research.

2.1.2. The Focus and Difficulty of Research. This article focuses on the field of the integration of smart city construction and the development level of the Internet of Things and proposes that only by fully combining the existing technical conditions, the construction of smart cities can truly achieve the goal of convenience and service to the people. The difficulty of the research on this subject lies in the different specific situations in different regions, and the development level of the Internet of Things also varies greatly. Under such a background, there are bound to be great differences in the conception and implementation steps of smart cities in various regions. How to evaluate the pros and cons of these strategies more scientifically. Therefore, for this research, the difficulty lies in how to determine the smart city algorithm. After careful consideration and multiple calculations, the research decided to adopt the entropy calculation method for simulation calculation, and the fluency of the smart city construction system was used as the main criterion for the level of science. With the aid of algorithms, the various plans or methods for smart city construction are assigned values, and the objective gaps in the economic strength and technical strength of various regions are minimized as much as possible. After determining the scientific evaluation model, the study summarized and analyzed the main problems existing in the construction of smart cities in my country and puts forward perfect suggestions for specific situations.

2.1.3. Research Framework. The research starts with a background introduction to the impact of smart city construction and regional industrial economic development in the context of wireless communication and the Internet of Things and extracts the key elements of smart city construction from the concept and practice of building smart cities with the help of Internet of Things technology in various parts of my country. We use this as the basis for determining the evaluation algorithm. Then, according to the calculation results, we sort out the main problems in my country's smart city construction and regional industrial economic development and analyze the existing problems in terms of scientific cognition, technological innovation, guarantee mechanism, and talent training, and based on the work experience, we summarize and put forward ideas and suggestions to solve the problem.

As shown in Figure 1, the research framework of this paper can be clearly seen.

2.2. Research Method. (1) Algorithms for smart city evaluation entropy are a measure of the degree of disorder in the system. It is in inverse proportion to the order of the system. In other words, the higher the value of entropy, the stronger the chaos of the system, the more difficult it is to extract valid data from it, and the worse the authenticity and scientificity of the data. The entropy method of system characteristics is

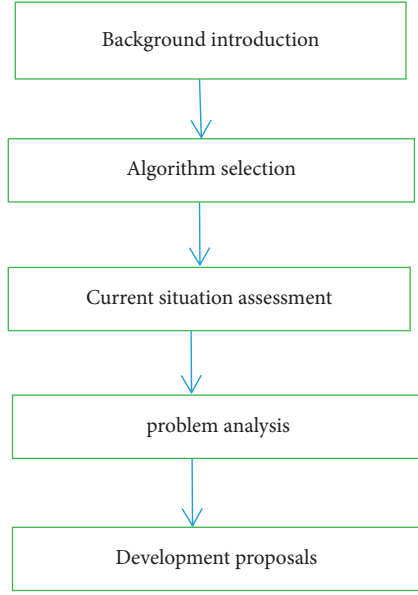


FIGURE 1: Research framework.

based on this inverse proportional relationship to determine the degree of influence of various elements on the system, so as to determine the weight of the elements⁴. The evaluation procedure of the entropy method is as follows.

Data standardization processing is performed according to the following formulas:

$$F'_{\alpha\beta} = \frac{F_{\alpha} - F_{\min}}{F_{\max} - F_{\min}}, \quad (1)$$

$$F'_{\alpha\beta} = \frac{F_{\max} - F_{\beta}}{F_{\max} - F_{\min}}. \quad (2)$$

(2) Investigation on smart city construction and regional industrial economic development under the background of Internet of Things.

2.2.1. Purpose of the Investigation. Through the investigation of three representative smart cities as examples, it mainly investigates the problems encountered in the construction process, and relevant suggestions are given. Through the analysis of the results, some suggestions are provided for the construction of smart cities and the development of the regional industrial economy.

2.2.2. Number of Questionnaires. According to the minimum sample size formula in statistics, the author sets the confidence level of the questionnaire to 80%, and the allowable error does not exceed 8%.

2.2.3. Data Source. Randomly 3 representative smart cities across the country are selected to conduct a questionnaire survey. According to the minimum sample size, the number of questionnaires distributed in the 3 cities is 300, 400, and 500, and the 3 cities are, respectively, denoted as City A, City

B, and City C. The number of questionnaires returned was 387, 459, and 574, respectively, as shown in Table 1.

2.3. The Impact of Wireless Communication and IOT on Smart Cities

2.3.1. The Impact of the Internet of Things on the Transportation Construction of Smart Cities. In recent years, my country's urbanization has developed rapidly, and all aspects of urban infrastructure and public services are facing great pressure. Although road network reconstruction projects are in full swing, and urban arterial roads continue to widen, congestion is particularly noticeable in large cities. In addition to this reason, the number of cars in big cities is increasing rapidly, the number of nonmotorized vehicles is huge, and some citizens do not comply with traffic. The urban transportation network design is backward, and urban public departments are difficult to integrate efficiently when carrying out their own work [45, 46]. These are also key issues that have led to a rapid increase in urban traffic pressure. The deployment of traffic resources through the Internet of Things can realize the efficient use of existing traffic resources, thereby effectively alleviating the city's traffic congestion. When the Internet of Things covers the entire city, real-time monitoring and real-time feedback on the status of each main lane can minimize traffic congestion. Combined with the urban safety guarantee system, the traffic congestion caused by road traffic accidents can be dealt with quickly and timely, and the city conditions can be greatly improved.

As shown in Figure 2, combined with the urban safety guarantee system, the traffic congestion caused by road traffic accidents can be dealt with quickly and timely, and the city conditions can be greatly improved.

2.3.2. The Impact of the Internet of Things on the Municipal Construction of Smart Cities. At this stage, the main direction of my country's smart city construction is to make municipal construction planning more scientific and convenient. In the original smart city plan, how to intelligently coordinate the government, enterprises, and the public to form a common force to promote city construction is the primary problem to be solved when building a smart city. The development of the Internet of Things technology provides strong technical support for the realization of this idea. On this basis, urban public service departments can not only implement cloud management of various services but also achieve efficient integration of urban resources [47]. In the background of the Internet of Things, it is possible to build an infrastructure and security monitoring system covering the entire city. The network is extended to a sufficient coverage area, and the sensor monitoring node can monitor every corner of the city, making the city's security level unprecedentedly improved, as shown in Figure 3.

As shown in Figure 3, the impact on the municipal construction of smart cities, it is mainly reflected in three points, namely scientific municipal planning, integrate city resources, and improve city safety.

TABLE 1: Summary of the distribution and recovery of questionnaires.

| Selected city code | Number of questionnaires issued | Number of questionnaires returned | Recovery rate (%) |
|--------------------|---------------------------------|-----------------------------------|-------------------|
| A | 400 | 387 | 96.75 |
| B | 500 | 459 | 91.8 |
| C | 600 | 574 | 95.67 |

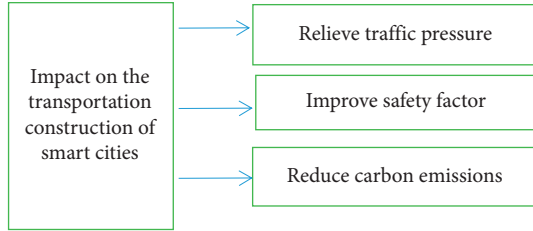


FIGURE 2: Impact on the transportation construction of smart cities.

2.3.3. *The Impact of the Internet of Things on the Medical Construction of Smart Cities.* As shown in Figure 4, the important reason for the increasing population of my country's big cities is that they have medical resources that are unmatched by towns and cities. The ever-increasing number of doctors keeps increasing the pressure on medical resources in my country's big cities. With the support of IoT technology, this pressure is expected to be alleviated. And citizens will enjoy high-quality medical services easily and quickly.

- (1) The Internet of Things can monitor the patient's condition in real time. Sensors will detect different conditions that can be worn on different patients and then connected to the Internet of Things inside the hospital through a wireless connection, so that doctors can monitor the patient's condition in real time [47]. In this way, not only can the patient's condition be dynamically monitored but also therapeutic measures can be applied for the first time.
- (2) The Internet of Things can exchange information about patients' diseases. On the basis of the concept of Internet of Things information sharing, patient information can break the limits of the interests of each hospital within the scope permitted by law and exchange and share among the hospitals where the patient is treated, which can not only reduce the economic burden of patients but also provide a useful reference for doctors to formulate treatment plans [48].

As shown in Figure 4, the impact on the municipal construction of smart cities, it is mainly reflected in two points: monitor the patient's condition in real time and exchange information about the patient's disease.

3. Results and Discussion

3.1. Data Analysis

3.1.1. *Classify and Summarize the Problems Encountered in the Construction of Smart Cities.* It can be seen from Figure 5 that in the process of smart city construction and regional industrial economic development in the

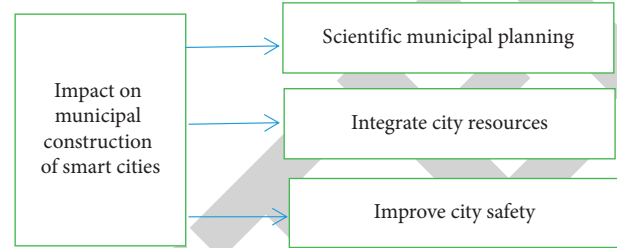


FIGURE 3: Impact on the municipal construction of smart cities.

background of the Internet of Things, the biggest problem encountered is information security, which accounts for about 43%. Subsequently, the lack of relevant talents accounts for information security, and the ratio is about 32%.

3.1.2. *Related Suggestions Are Given.* It can be seen from Table 2 that the introduction of talents accounted for the largest proportion of relevant suggestions, accounting for 46%, and then rational planning of industrial structure, accounting for about 29%.

3.2. Results

3.2.1. *Insufficient Understanding of Smart Cities.* Some cities are still at the stage of hearsay about "smart cities". Although they have also put forward specific development goals, they have not yet formulated specific plans on this basis, and government agencies have not issued relevant policy documents. There is a lack of core support for the smart city to be developed, the experience and model of other cities are completely copied, and the participation of social forces is seriously insufficient.

3.2.2. *Lack of Technological Innovation.* Due to the impact and influence of people's ideology, technological, scientific knowledge and skills, environmental conditions, and many other reasons, many traditional industries in my country still adopt existing development methods and models and have not realized the power of innovation on the enterprise itself in the context of the Internet of Things. The survey found that many small and medium-sized enterprises need to use the types of equipment, and the technology invested is in a backward state, not reaching the industry average. Its products lack sufficient added value, and the market performance is not good, which directly affects the company itself.

3.2.3. *The Guarantee Mechanism Is Not Perfect.* Although smart cities have been reported frequently, they are still castles in the sky for most cities with weaker economies.

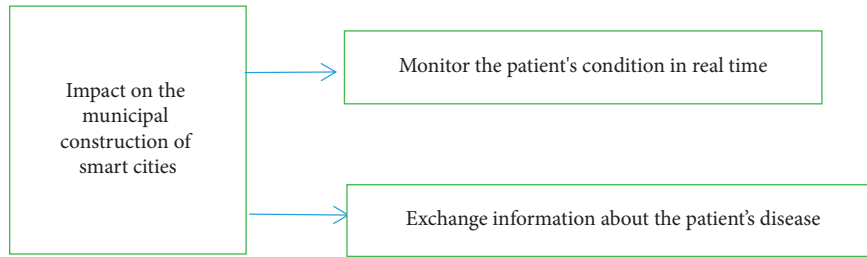


FIGURE 4: Impact on the municipal construction of smart cities.

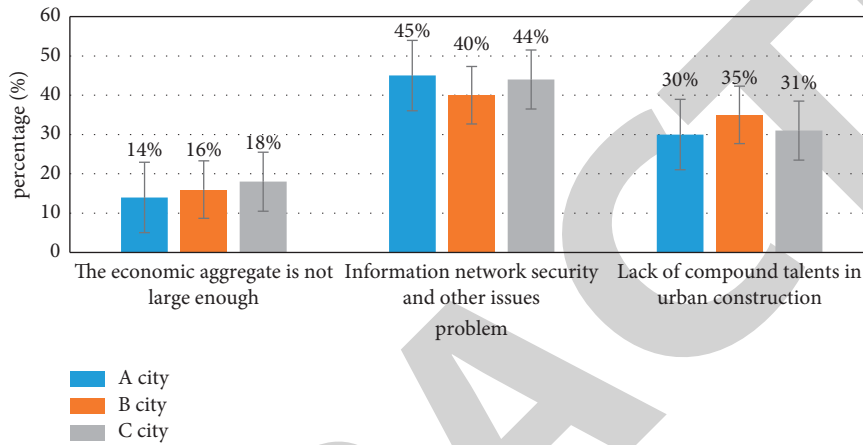


FIGURE 5: Type of problem.

TABLE 2: Related suggestions are given.

| | A City (%) | B City (%) | C City (%) |
|--|------------|------------|------------|
| Establish a talent introduction policy | 46 | 47 | 46 |
| Reasonable urban industry planning | 28 | 30 | 29 |
| Introduce high-tech facilities | 23 | 21 | 27 |

Even in many cities that have already begun construction, the mechanism for ensuring the progress of this work is still very inadequate. This requires us to vigorously improve the government's support policies while promoting the development of smart cities; otherwise, it will be difficult to fully realize the coordinated development of the urban economy.

3.2.4. The Talent Gap Leads to a Weak Technical Foundation. The construction of a smart city requires the support of mature Internet of Things technology, and the latter has very high requirements for professional talents. Judging from the current situation, many smart cities are under construction or proposed to be built in my country, except for a few cities where technical talents are concentrated, almost all purchase special designs and program integration from outside. This makes it difficult to sustain the later maintenance and technological update of smart cities as shown in Figure 6.

As shown in Figure 6, problems in the construction of smart cities and regional industrial economy are mainly in the following aspects: the guarantee mechanism is not perfect, talent gap, lack of technology, and lack of knowledge.

3.3. Main Strategies for Smart City Construction and Regional Industrial Economy

3.3.1. Do a Good Job in the Design of Top-Level Planning. When building a smart city, if it is possible to ensure that the design work of the highest design level has high integrity, then the construction of the smart city can basically be completed effectively, and at the same time, it can be fully integrated with the local industrial economy to achieve better development increase. In the context of the rapid development of the Internet of Things technology, the government must plan the construction of smart cities with the vision of sustainable development and use it as the basis for future development. At the same time, the actual conditions and historical progress of the city must be considered in order to adopt long-term planning methods to ensure that all detailed system rules can be effectively applied.

3.3.2. Strengthen Technological Innovation. At this stage, the driving force of my country's economic growth is gradually shifting to science and technology, and science has become a new driving force for urban development. The Chinese

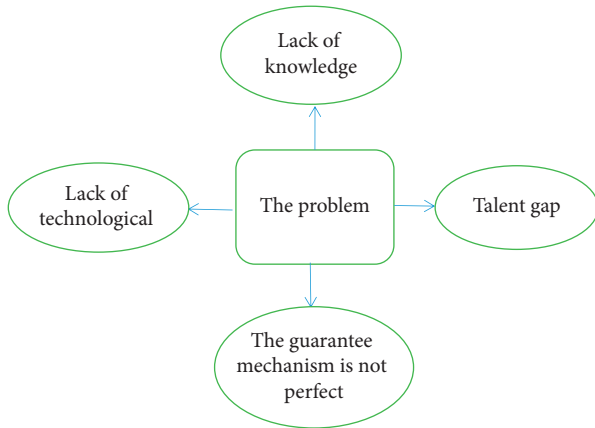


FIGURE 6: Problems in the construction of smart cities and regional industrial economy.

government has also constantly emphasized the need to achieve steady economic development through advances in science and technology. On the one hand, it is to optimize some traditional industries as a whole to make their transformation more reasonable. At the same time, it is necessary to invest as much as possible in new technologies, so as to improve its functions and increase its technical content as a whole. Some local traditional industries will be upgraded accordingly to meet the basic development needs at that time. On the other hand, manufacturing has always been a key industry for urban development. However, due to technological innovation, the working mode of some industries has been relatively outdated and has been gradually eliminated by the times.

3.3.3. Further Improve the Five Mechanisms. The five mechanisms are our guidelines for building smart cities, and they are also the center that cannot be ignored. It includes innovation, coordination, green, openness, and sharing. The creation of our smart city must adhere to this center and constantly adjust and improve it according to actual needs. First of all, the company's internal leaders must configure the organization mechanism according to their actual situation to complete the overall coordination of various construction contents and improve the initial defects. Second, we optimize the original market driving force, look for its own content defects, conduct innovative research to invest all capital costs in appropriate projects, and then use its own leverage and guidance to fully reveal its sexual impact.

4. Conclusions

With the increasing requirements of urban residents for the living experience, the development trend of smart cities is also more obvious. Smart city planning must always adhere to the principle of "people-oriented", and on the premise of meeting various construction specifications, we make planning and designs that meet the needs of residents, improve the quality of life of residents, create a new form of urban community, and make it more in line with urban

planning and development requirements. Wireless communication technology enables faster communication in smart cities, and it can accelerate the efficiency of communication and cooperation among urban citizens, while IoT technology can interconnect electronic devices throughout the smart city, increase the speed of city operation, and ultimately improve the speed of urban economic development.

The development of a city is inseparable from the surrounding area. Therefore, the construction of a smart city has a very direct relationship with the overall industrial layout and economic development of the area where the city is located. In the design of building a smart city, we must pay attention to avoiding representative problems in other cities and fully integrate the characteristics and actual needs of the city itself and surrounding areas on the basis of respecting basic principles. We use scientific entropy calculation to determine the proportion of various elements in the construction of smart cities. In the actual survey, this research found that there are still some problems in the construction and application of smart cities and the development of the regional economy. Then, it conducted a survey of talents in other fields. The survey results can be drawn: first, in the era of mobile Internet of Things and in the context of my country's smart city construction and application, as well as the development of regional industries and economy, one of the biggest problems that need to be encountered is information security, which accounts for about 41% of the time. Then, there is a lack of relevant professionals. It accounts for about 31%. Second, related policies and recommendations accounted for the largest proportion of talent introduction, accounting for about 45%, and then rationally planning their own industrial structure, only about 28%. Because the traditional method is still used in the questionnaire survey, it is easy to obtain invalid questionnaires, resulting in low reliability of the data. In the future, we can consider designing a new questionnaire survey method to improve the questionnaire recovery rate and reliability, thereby increasing the amount of data. The authenticity of the investigation will ultimately increase the efficiency of the investigation and the credibility of the findings. In this regard, we must actively respond and consolidate the talent pool for building smart cities. With the deepening of research and the further development of Internet of Things technology, our smart city design will inevitably be more scientific, practical, and forward-looking. In the follow-up research, the team will select representative smart city construction cases for analysis and focus on analyzing their problems and experiences in the construction process.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

- [1] W. Lu, "Research on the construction of coastal regional smart cities in the process of Jing-jin-ji integration," *Boletín Tecnico/Technical Bulletin*, vol. 55, no. 18, pp. 186–193, 2017.
- [2] M. Hong, C. Peng, M. Niu, and Z. Xu, "Research on the construction effect evaluation system of smart CBD: a case study in Jiangbei New District, Nanjing, China," *Advances in Civil Engineering*, vol. 2021, no. 2, pp. 1–19, 2021.
- [3] A. Nadal, R. Alamús, L. Pipia, and A. RuizCorberaCuervaRieradevallJosa, "Urban planning and agriculture. Methodology for assessing rooftop greenhouse potential of non-residential areas using airborne sensors," *Science of the Total Environment*, vol. 601–602, pp. 493–507, 2017.
- [4] Z. He, Z. Liu, H. Wu, and X. GuZhaoYue, "Research on the impact of green finance and fintech in smart city," *Complexity*, vol. 2020, no. 3, pp. 1–10, 2020.
- [5] J. Tang, "The discussion on hot spot and Frontier of energy research in smart cities," *IOP Conference Series: Earth and Environmental Science*, vol. 631, no. 1, Article ID 012085, 2021.
- [6] X. Dong, T. Shi, W. Zhang, and Q. Zhou, "Temporal and spatial differences in the resilience of smart cities and their influencing factors: evidence from non-provincial cities in China," *Sustainability*, vol. 12, no. 4, p. 1321, 2020.
- [7] S. Kariminia, S. Motamedi, S. Shamshirband, and R. PetkovićRoyHashim, "Adaptation of ANFIS model to assess thermal comfort of an urban square in moderate and dry climate," *Stochastic Environmental Research and Risk Assessment*, vol. 30, no. 4, pp. 1189–1203, 2016.
- [8] I. G. Capeluto and O. Ben-Avraham, "Assessing the green potential of existing buildings towards smart cities and districts," *Indoor and Built Environment*, vol. 25, no. 7, pp. 1124–1135, 2016.
- [9] Z. Lv, D. Chen, and H. Lv, "Smart city construction and management by digital twins and BIM big data in COVID-19 scenario," *ACM Transactions on Multimedia Computing Communications and Applications*, 2022.
- [10] Q. Sun, K. Lin, C. Si, Y. Xu, S. Li, and P. Gope, "A secure and anonymous communicate scheme over the Internet of Things," *ACM Transactions on Sensor Networks*, vol. 18, no. 3, pp. 1–21, 2022.
- [11] L. Alcaide Muñoz and M. P. Rodríguez Bolívar, "Different levels of smart and sustainable cities construction using e-participation tools in European and Central Asian Countries," *Sustainability*, vol. 13, no. 6, p. 3561, 2021.
- [12] A. Michael and M. A. Hann, "Innovation and craft in a climate of technological change and diffusion," *The Research Journal of the Costume Culture*, vol. 25, no. 5, pp. 708–717, 2017.
- [13] Z. Lv, S. Lv, H. Feng, and H. Lv, "Clinical characteristics and analysis of risk factors for disease progression of COVID-19: a retrospective Cohort Study," *International Journal of Biological Sciences*, vol. 17, no. 1, pp. 1–7, 2021.
- [14] B. Li, D. Tong, Y. Wu, and G. Li, "Government-backed 'laundering of the grey' in upgrading urban village properties; ningmeng apartment project in shuiwei village, shenzhen, China," *Progress in Planning*, p. 146, 2021.
- [15] S. Fan, Y. Wang, S. Cao, T. Sun, and P. Liu, "A novel method for analyzing the effect of dust accumulation on energy efficiency loss in photovoltaic (PV) system," *Energy*, vol. 234, Article ID 121112, 2021.
- [16] T. V. Malysheva, A. I. Shinkevich, S. S. Ostanina, E. L. Vodolazhskaya, and V. O. Moiseyev, "Perspective directions of improving energy efficiency on the meso and micro levels of the economy," *Journal of Advanced Research in Law and Economics*, vol. 7, no. 1, pp. 75–83, 2016.
- [17] S. Fan, Y. Wang, S. Cao, B. Zhao, T. Sun, and P. Liu, "A deep residual neural network identification method for uneven dust accumulation on photovoltaic (PV) panels," *Energy*, vol. 239, Article ID 122302, 2022.
- [18] T. Cai, M. Dong, H. Liu, and S. Nojavan, "Integration of hydrogen storage system and wind generation in power systems under demand response program: a novel p-robust stochastic programming," *International Journal of Hydrogen Energy*, vol. 47, no. 1, pp. 443–458, 2022.
- [19] Z. Li, K. Zheng, and S. Wu, "Research on the construction elements of the new generation power system," *IOP Conference Series: Earth and Environmental Science*, vol. 687, no. 1, Article ID 012104, 2021.
- [20] Y. Lin, H. Song, F. Ke, W. Yan, Z. Liu, and F. Cai, "Optimal caching scheme in D2D networks with multiple robot helpers," *Computer Communications*, vol. 181, pp. 132–142, 2022.
- [21] J. Ji, K. Wang, and Z. H. Wang, "Research on the connotation and key technologies of the Urban Information Model (CIM) that empowers the construction of smart cities," *Urban Development Research*, vol. 28, no. 3, p. 5, 2021.
- [22] S. Z. Gu and M. Wang, "Theoretical thinking and strategic choice of smart city construction," *China Population, Resources and Environment*, vol. 22, no. 5, pp. 74–80, 2021.
- [23] H. Du, Y. Deng, J. Xue, D. Meng, Q. Zhao, and Z. Xu, "Robust online CSI estimation in a complex environment," *IEEE Transactions on Wireless Communications*, p. 1, 2022.
- [24] Z. Wang, R. Ramamoorthy, X. Xi, K. Rajagopal, P. Zhang, and S. Jafari, "The effects of extreme multistability on the collective dynamics of coupled memristive neurons," *The European Physical Journal - Special Topics*, 2022.
- [25] Z. Wang, R. Ramamoorthy, X. Ramamoorthy, H. Xi, and Namazi, "Synchronization of the neurons coupled with sequential developing electrical and chemical synapses," *Mathematical Biosciences and Engineering*, vol. 19, no. 2, pp. 1877–1890, 2021.
- [26] X. H. Hong, L. J. Fan, and X. N. Hong, "Opening and market-oriented utilization of government big data in the construction of smart cities," *Big Data Research*, vol. 3, no. 2, pp. 17–26, 2016.
- [27] C. J. Li, "Big data technology and smart city construction-based on the dual perspective of technology and management," *Journal of Tianjin Administration Institute*, vol. 17, no. 4, pp. 39–45, 2015.
- [28] M. Lom and O. Pribyl, "Smart city model based on systems theory," *International Journal of Information Management*, vol. 56, p. 102092, 2021.
- [29] Y. Zhan and S. Li, "Smart city construction, entrepreneurial vitality and high-quality economic development—analysis from the perspective of green total factor productivity," *Finance and Economics Research*, vol. 48, no. 1, p. 15, 2022.
- [30] S. S. Tang, Y. Q. Zhang, Z. G. Shan, W. Wang, and Y. Q. Zhang, "The development status, situation and policy suggestions of new smart cities in my country," *E-government*, no. 04, pp. 70–80, 2020.
- [31] S. Q. Guo, "Construction of smart bay area in guangdong-Hong Kong-Macao greater bay area: practical obstacles and innovation reform," *E-government*, no. 12, pp. 59–68, 2020.
- [32] M. Wang, Y. F. Li, and S. C. Ma, "Does smart city construction promote the upgrading of industrial structure?" *Science of Finance and Economics*, no. 12, pp. 56–71, 2020.

Retraction

Retracted: Innovation and Digital Construction of Cultural Tourism Industry under the Background of Big Data and Internet of Things

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] B. Liu, "Innovation and Digital Construction of Cultural Tourism Industry under the Background of Big Data and Internet of Things," *Mobile Information Systems*, vol. 2022, Article ID 9019536, 8 pages, 2022.

Research Article

Innovation and Digital Construction of Cultural Tourism Industry under the Background of Big Data and Internet of Things

Bo Liu 

Department of Management, East University of Heilongjiang, Harbin 150000, China

Correspondence should be addressed to Bo Liu; liubo_vip@outlook.com

Received 20 May 2022; Revised 16 June 2022; Accepted 29 June 2022; Published 31 July 2022

Academic Editor: Amit Gupta

Copyright © 2022 Bo 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.

In recent years, the concept of the Internet of Everything has gradually entered all walks of life, and the combination of big data technology and the Internet of Everything applied to other industries has become the current trend of industrial innovation. The integration between the tourism industry and the cultural industry is an inevitable trend for the sustainable development of the tourism industry. New science and technology are constantly innovating the way of life of human beings. If the tourism industry wants to maintain a state of rapid development, it must focus on the innovative development and digital construction of cultural tourism, develop new cultural tourism products, and propose new marketing innovation models. This promotes faster and better development of the tourism industry. Based on this, this paper designs a questionnaire and uses statistical methods to analyze the data obtained by the questionnaire, summarizes the current problems in the innovation and digital construction of the cultural tourism industry, and proposes solutions in a targeted manner, in order to improve the cultural tourism industry. Healthy development provides incremental contributions.

1. Introduction

1.1. Big Data. Big data, in short, is a collection of massive amounts of data [1]. Big data is often limited to two aspects: on the one hand, it is limited by the cost of data [2]. In order to meet the needs of big data processing, there are not only hardware and software but also labor costs and overlapping time, so it cannot be used without restraint [3]; on the other hand, it is also limited by data processing technology [4]. The fusion of big data and the scope of effective practice depends on the processing of the data of the person responsible for the implementation, which requires both technical and professional knowledge of data processing [5]. The absence of either of these two factors may lead to no value in data processing meaning that these two factors are crucial [6].

1.2. Internet of Things. The development of the Internet of Things provides a new development direction for the progress of enterprises [7–9]. The definition of the Internet of Things is to use radio frequency identification RFID,

global positioning system GPS, and other message sensing equipment, according to a certain protocol, to connect any item through the Internet of Things domain name, information exchange, and communication in order to achieve intelligent identification and positioning. A network concept for tracking, monitoring, and management [10–13]. The concept of Internet of Things technology has been prevalent in academia in the 1980s. In recent years, branch applications of Internet of Things technology have gradually entered all walks of life [14].

1.3. Cultural and Tourism Integration Innovation. The integration of culture and tourism not only provides a new way for the optimization and upgrading of culture and tourism in the development process [15] but also provides a new direction for the innovative development of culture and tourism [16]. With the continuous innovation of the tourism industry and the continuous raging of the epidemic, many tourism industries in my country are showing signs of decline [17]. Through the integration of culture and tourism,

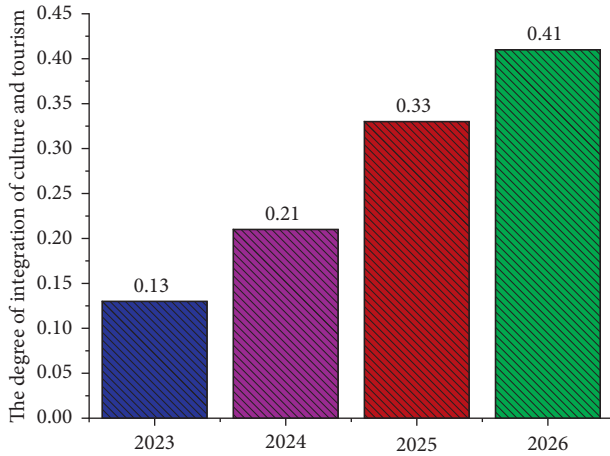


FIGURE 1: Innovation and development trend of cultural tourism industry.

not only can the red tourism industry continue to develop under the trend of economic globalization, but also a new development direction for my country's tourism industry under the epidemic situation relying on the integration of culture and tourism can better utilize the advantages of these tourism resources to maximum [18].

With the improvement of tourists' living standards, the broadening of their horizons, and the increase of knowledge, tourists are no longer satisfied with simple sightseeing tours and product consumption but pursue more aesthetic experience and feel the cultural connotation carried by tourism products [19–22]. As the crystallization of human civilization and culture and art, national culture reflects the spiritual characteristics of a nation [23]. It contains unique national history and humanistic characteristics [24]. It has played an active role in meeting the cultural needs of tourists [25]. Combined with human civilization and national culture, it will provide tourists with a more immersive experience [26, 27]. Therefore, it is necessary to conform to the trend of the times, dig deep into the characteristic cultural tourism resources, continuously combine various new science and technology, meet the characteristic and multilevel needs of mass tourism, promote the creative transformation and innovative development of national culture in tourism, and promote the cultural tourism industry [28–30]. The development of tourism industry has reached a new level [31]. The innovative development of the cultural tourism industry has become a trend in the future, and the agency predicts its growth rate in the next 4 years as shown in Figure 1.

2. Questionnaire Survey and Analysis

In order to understand the current situation of innovation and digital construction of the cultural tourism industry, this paper conducts an online survey on 50 large-scale tourism enterprises in charge of cultural tourism and technical departments and 1000 tourism enthusiasts

through the questionnaire star platform. The content includes the sense of tourist experience, the marketing and publicity efforts of tourism companies on cultural tourism, and the current digital construction of various tourism companies. Through the half-month survey, a total of 2,000 questionnaires were distributed, 1,997 questionnaires were recovered, and 1,996 valid questionnaires were obtained. The effective recovery rate of the questionnaire was close to 100%. In the questionnaire content, the sense of tourists' experience is highly related to the needs of tourism enterprises' cultural and tourism innovation and digital construction. From the perspective of customers, it can also reflect the actual requirements of current industrial innovation. A total of 1,000 tourist questionnaires were distributed and selected three key data are displayed, and the data related to tourists' experience in the survey are shown in Table 1.

From the data in Table 1, it can be seen that under the current cultural and tourism integration background, tourists' recognition of cultural tourism is still at a low level. Tourist A's recognition of tourism under the background of cultural and tourism integration is less than 20%, while the recognition of C tourists is less than 20%. The highest is not more than 30%. The surveyed tourists generally reflect that they cannot deeply experience the cultural scenes and connotations contained in tourist destinations during tourism. It can be seen that the current cultural tourism industry still needs to be innovated according to the needs of tourists.

The marketing and publicity of cultural tourism by tourism enterprises is highly related to the development of the enterprise. The innovation of cultural tourism industry is also gradually developed on the basis of marketing and publicity. This time, the data of three typical tourism enterprises are selected for display, among which the survey involves tourists. The experience data are shown in Table 2.

From Table 2, it can be seen that the current effective marketing of cultural tourism by tourism companies still accounts for a poor proportion of all marketing. Among them, the effective marketing of company A accounts for 29%. Compared with all the marketing costs it pays, the effectiveness is still less than 30%. From the perspective of effective publicity, the effectiveness of corporate C's publicity is the highest, reaching 28%, but the effective publicity of company B is less than 20%. The effectiveness of publicity and marketing of each company still needs to be improved.

The validity and reliability of the questionnaire can only be found in the actual test. Through the theoretical analysis of reliability and validity, the correlation coefficient of the questionnaire in this paper is shown in Table 3.

From Table 3 and the actual questionnaire reliability theory, it can be seen that the data about the tourist experience questionnaire is real and effective, and it is more in line with the actual situation, so it is believed that the survey and analysis results are valid.

The current digital construction of tourism companies is highly related to the innovation of the company and the innovation of the entire industry, and digital construction is also directly related to the experience of tourists. This

TABLE 1: Tourist experience under the background of cultural and tourism integration.

| Tourist code | Experience feedback | Recognition degree |
|--------------|--|--------------------|
| A | No cultural content | 0.19 |
| B | Only tourism, no culture | 0.21 |
| C | Inability to resonate with the environment | 0.25 |

TABLE 2: Marketing and promotion of cultural tourism by tourism enterprises.

| Tourist code | Marketing effectiveness | Publicity effectiveness |
|--------------|-------------------------|-------------------------|
| A | 0.29 | 0.25 |
| B | 0.27 | 0.19 |
| C | 0.26 | 0.28 |

TABLE 3: Reliability and validity analysis.

| | Reliability | Validity |
|-------|--------------|------------|
| Value | Alpha = 0.81 | KMO = 0.79 |

TABLE 4: Current digital construction of tourism enterprises.

| Tourist code | Application rate of big data | Application rate of IoT | Application rate of other IT systems |
|--------------|------------------------------|-------------------------|--------------------------------------|
| A | 0.04 | 0.02 | 0.19 |
| B | 0.03 | 0.01 | 0.13 |
| C | 0.03 | 0.01 | 0.11 |

TABLE 5: Reliability and validity analysis.

| | Reliability | Validity |
|-------|--------------|------------|
| Value | Alpha = 0.82 | KMO = 0.83 |

time, three typical tourism companies were selected to display the survey content and data. The details are shown in Table 4.

From the data in Table 4, it can be seen that the digital construction of the three typical tourism companies currently surveyed is relatively poor. Among them, the application rate of big data and the application rate of the Internet of Things can reflect the degree of digital construction of enterprises. In fact, the application rate of big data is the highest. Company A is less than 5%, and the IoT application rate of companies B and C is also maintained at the level of 1%. Although the application rate of other IT systems has reached more than 10%, it is still less than 20%. The overall situation of this data is sufficient. It shows that the digital construction of enterprises is still at a poor level.

Through the theoretical analysis of reliability and validity, the questionnaire correlation coefficient of digital construction is obtained as shown in Table 5.

It can be seen from Table 5 and the actual questionnaire reliability theory that the data of this digital construction questionnaire survey is real and effective, and it is more in line with the actual situation, so it is believed that the survey and analysis results are valid.

In order to analyze the data collected by the questionnaire, this paper uses machine learning related algorithms to process the data, and the formulas involved are shown in (1a)–(1e).

$$\nabla_{\theta^u} J \approx \frac{1}{N} \sum_i \left[\nabla_a Q(s, a | \theta^Q) |_{s=s_i, a=f(s_i)} \nabla_{\theta_f} \mu(s | \theta^u) |_{s=s_i} \right], \quad (1a)$$

$$\eta_{E_H} = \frac{1}{N} \sum_{i=0}^N E_{H,i}, \quad (1b)$$

$$\sigma_\zeta^2 = \frac{1}{N} \sum_{i=0}^N (\zeta_i - \eta_\zeta)^2,$$

$$\sigma_{E_H}^2 = \frac{1}{N} \sum_{i=1}^N (E_{H,i} - \eta_{E_H})^2, \quad (1c)$$

$$\hat{b}_t = \frac{b_t}{\lambda_1},$$

$$\hat{\zeta}_t = \frac{(\zeta_t - \eta_\zeta)}{\sigma_\zeta}, \quad (1d)$$

$$\hat{E}_{H,t} = \frac{(E_{H,t} - \eta_{E_H})}{\lambda_2 \sigma_{E_H}}. \quad (1e)$$

3. Current Issues of Innovation and Digital Construction of the Cultural Tourism Industry

3.1. Tourists Cannot Experience the Deep Integration of Culture and Tourism. From the statistics of the questionnaire data, it can be found that under the background of the current integration of culture and tourism, tourists still cannot effectively obtain the culture contained in the tourist destination during their travel [32]. For example, a surveyed tourist said that when visiting the Yellow Crane Tower in Wuhan, he did not deeply experience the feeling of historical poets reciting poems in the Yellow Crane Tower, and he could not see a detailed introduction to the scenes of poets writing poems in the Yellow Crane Tower scenic spot [33] affects the experience of tourists [34]. Tourists' recognition of the integrated development of culture and tourism is also low. According to interviews with technical departments of tourism enterprises and professionals related to innovation in the cultural tourism industry, the main reason why tourists cannot experience the deep integration of culture and tourism is the lack of technical assistance [35]. Since tourists are more accustomed to the way of obtaining detailed information on

various scenes in computers and mobile phones in daily life, they will have a poor experience even if they cannot obtain detailed information about the culture at that time in the tourist scene [36]. Therefore, tourism enterprises and industrial planning need to innovate from a technical point of view.

3.2. Insufficient Marketing and Publicity. In the face of the increasing development of cultural tourism, the marketing method of tourism must be changed in order to occupy a high position in the tourism industry [37]. The marketing method of cultural tourism should ultimately focus on culture [38]. Without culture, tourism marketing would be meaningless. The traditional tourism marketing products are mainly tourist attractions, and many tourist attractions will continue to develop new tourist attractions to attract more tourists. The development of new tourist attractions is not a small amount [39]. In the long run, not only will it not attract more tourists, but the investment in the construction of scenic spots will also hinder the development of the local economy [40]. Therefore, in the innovation of tourism marketing methods, enterprises can focus on reflecting the local cultural connotation and carry out the combined marketing of ethnic cultural tourism products. The combination marketing of cultural tourism products not only realizes the integration of resources but also meets the diversified needs of tourists [41]. While focusing on the combination marketing of cultural tourism products, it is necessary to strengthen management and services. Only in this way can tourists be satisfied with the local level, and can truly retain tourists and retain consumption.

According to the analysis of the questionnaire survey, it is found that the current marketing situation is not ideal. In fact, the enterprises do not use advanced network technology and new technology for marketing nor do they design relatively novel marketing plans. In addition, in terms of publicity, tourism companies have failed to make full use of the characteristics of the current self-media era, combined with various new technologies to promote online publicity, and offline publicity also lacks the support of characteristic technologies, but in fact, other industries have deeply integrated promotion of new technologies. For example, real estate companies already have VR viewing functions in their APPs. In fact, the application of VR to the cultural tourism industry will bring tourists a stronger sense of experience, and online tourism methods are also advocated during the epidemic. Tourism companies have not taken such an action.

3.3. The Degree of Digital Construction Is Low and Personalized Recommendation Cannot Be Completed. Personalized recommendation has achieved great success in the field of e-commerce, and the field of short video has also been occupied by personalized recommendation in the past two years. This technology provides key technical support for companies to capture users. The current level of digital construction in various industries is also

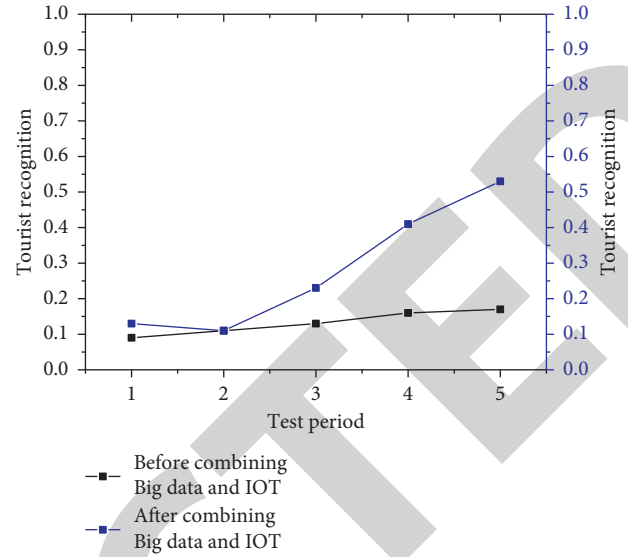


FIGURE 2: Changes in tourists' recognition of cultural tourism.

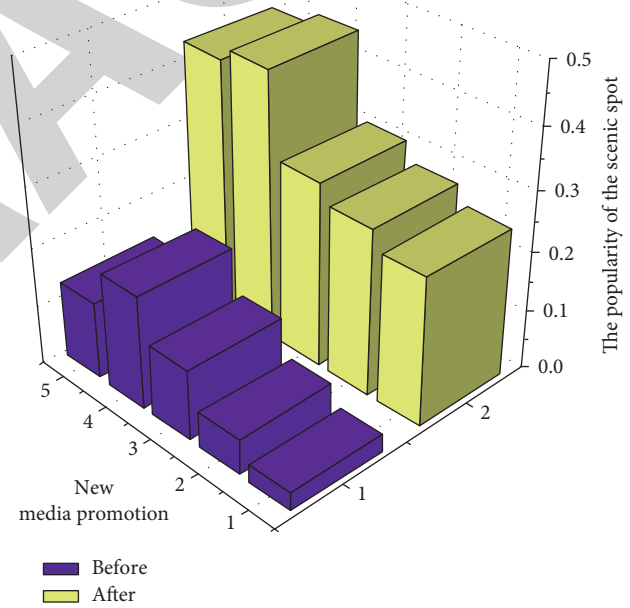


FIGURE 3: Changes in network popularity of scenic spots.

measured by a technology similar to personalized recommendation. However, tourism companies have not put this technology into practical application. Tourists cannot experience the customized tourism plan in the process of participating in cultural tourism. This is not enough for the cultural experience of the tourist destination, and the final tourist experience is also poor. In addition, the current tourism enterprises do not have enough talent training for big data and Internet of Things technologies, and the application rate of various new technologies is relatively low, resulting in the inability of tourism enterprises to innovate in digital construction.

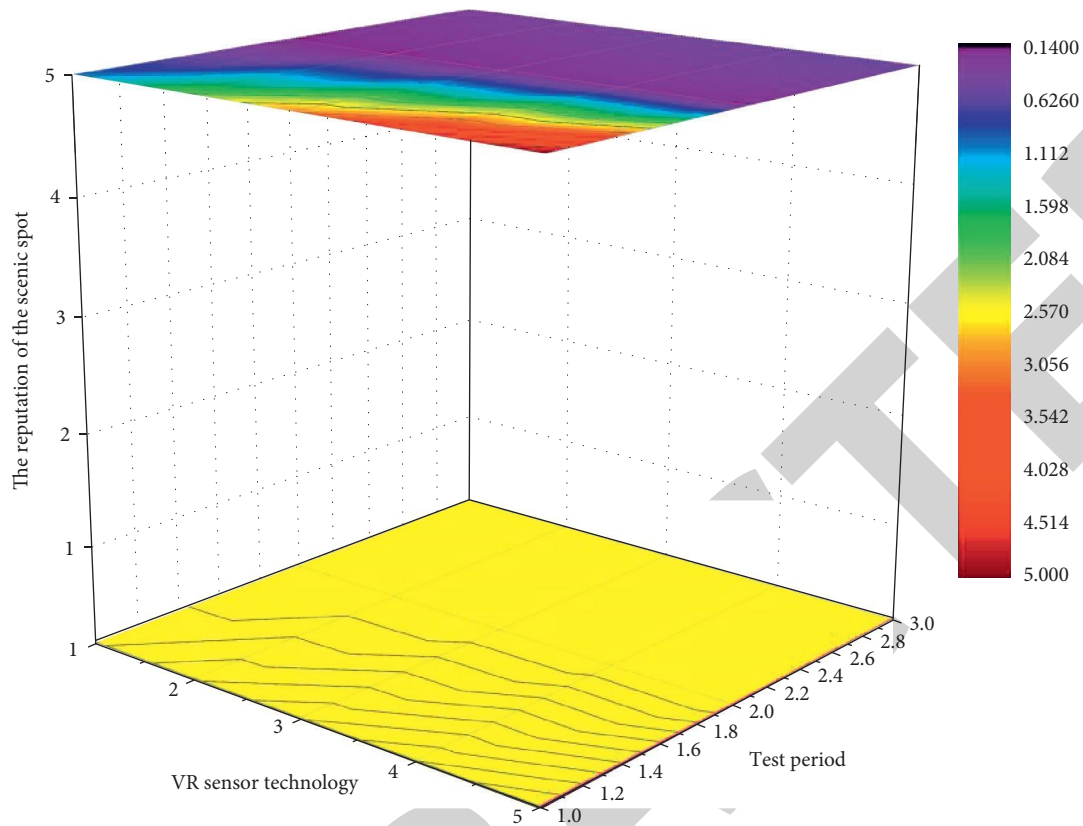


FIGURE 4: Changes in the reputation of scenic spots.

4. Countermeasures for Cultural Tourism Industry Innovation and Digital Construction Combined with Big Data and Internet of Things Technology

4.1. Combining Big Data and IoT to Provide Tourists with an Immersive Travel Experience. VR technology mainly uses various sensors and some visual technologies to complete the sensory experience of virtual reality, and the sensors are mainly realized by the Internet of Things technology. Big data technology can provide corresponding data for subsequent tourists based on the historical information in the database, combined with the historical operations of other tourists. In response to the problem that tourists cannot experience the actual local culture in the tourist destination, it can be improved by combining big data and IoT sensor technology to provide tourists with specific scenes in specific locations. For example, for the Yellow Crane Tower scenic spot in Wuhan, VR poetry reading equipment can be set up next to the poets' poem recitation positions in the scenic spot, and the combination of VR and sensors can enhance the experience of tourists so that tourists can deeply feel the culture of the scenic spot. Big data can be used to analyze the data of historical tourists using VR equipment and get the most frequently used VR equipment in the scenic area, and add more equipment and some incidental products to the equipment area to ensure the immersive experience of tourists to increase the income of tourism enterprises.

Through the secondary investigation of related enterprises, it is found that after the use of big data and Internet of Things technology to improve the experience of tourists, tourists' recognition of cultural tourism has been greatly improved. The specific situation is shown in Figure 2.

4.2. Combining New Technologies to Enhance Marketing and Publicity. In recent years, the influence of new media has been increasing in various industries, and it has also played a huge role in the cultural tourism industry, especially in the stage of tourism promotion and marketing. The current lack of effective marketing and publicity of various enterprises can be solved in steps. First of all, by making full use of the power of the media, traditional media, such as TV advertisements and outdoor advertisements, can be used to preheat the cultural tourism market of enterprises so that the public can have an impression of the scenic spot. You can also introduce live broadcasts through new media platforms such as WeChat public account, Douyin, and Kuaishou to increase the popularity of the scenic spot. In addition, the scheme design is carried out from the perspective of offline publicity and marketing of the scenic spot, and the promotion is carried out in combination with technologies such as VR sensors. For example, VR simulated landscape painting can give tourists a strong sense of visual impact, and various novel tourism activities can also be carried out to stimulate consumers' desire to participate, and through

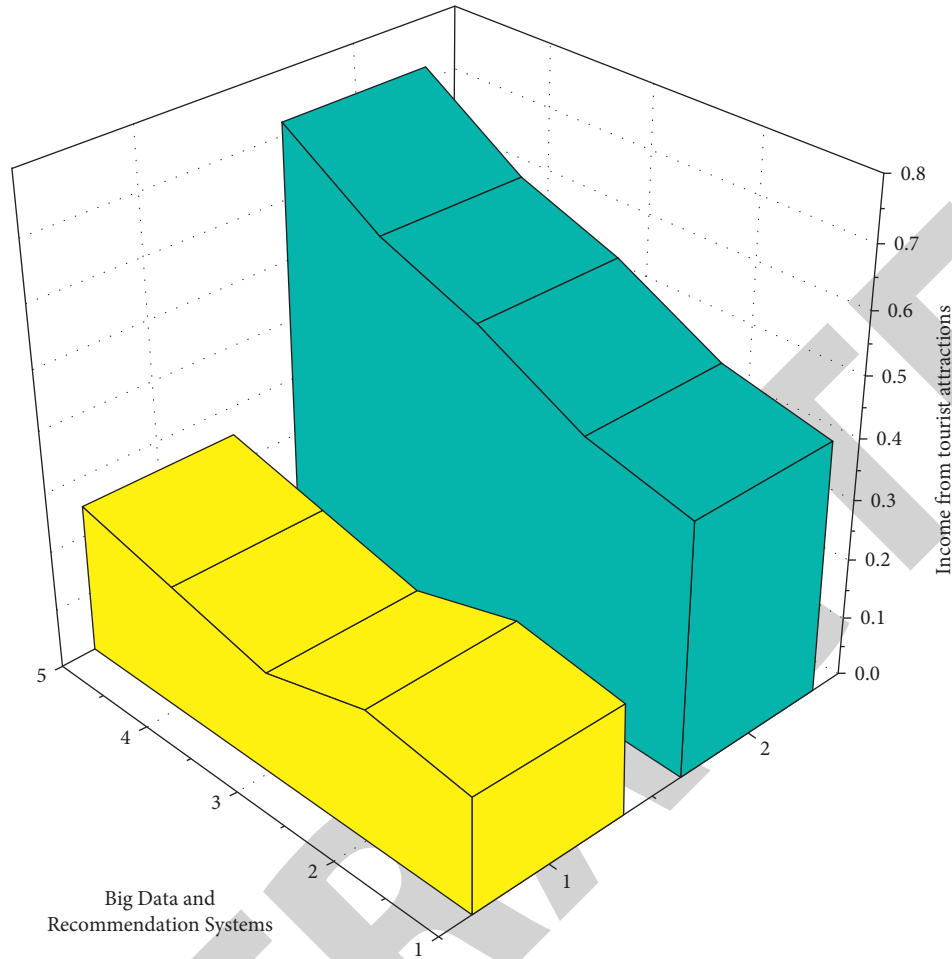


FIGURE 5: Changes in scenic income after personalized recommendation.

novel and interesting activities, the reputation of the scenic spot in the hearts of tourists can be enhanced. At present, some self-media platforms are not only popular among young people but also widely spread among the elderly, such as Kuaishou and Douyin. Various tourism activities in scenic spots can use these self-media platforms to strengthen publicity and diffusion. Through the secondary investigation of related enterprises, it was found that after adopting new media methods for publicity and marketing, the popularity of the scenic spot has been greatly improved. The specific situation is shown in Figure 3.

Through the secondary investigation of related companies, it was found that after the adoption of VR sensor technology for offline promotion of scenic spots, the changes in the reputation of scenic spots are shown in Figure 4.

4.3. Personalized Service Recommendation Combined with Big Data Technology. Aiming at the low degree of digital construction of the current cultural tourism industry, it can be solved based on the introduction of equipment such as the Internet of Things, combined with big data and recommendation system technology. Only through the objective analysis and calculation of passenger information through big data technology and computer technology can we improve

the service model of the tourism industry, formulate personalized services for customers, and realize the perfect integration of resources and services. Among them, big data technology can conduct comprehensive analysis according to the historical data stored in the database, and the recommendation system can recommend the tourists' favorite scenic spot services and content. For homestays, the recommendation system will recommend various homestays to Company A based on the results of big data analysis. Tourists B like to watch dramas in their play history, and the recommendation system will recommend the schedule of cultural dramas related to scenic spots to tourists B to ensure that the income of various projects in the scenic spot will ultimately increase the overall income of the scenic spot. Through the secondary investigation of related enterprises, it is found that after the adoption of big data and recommendation system technology, the income of tourist attractions has been greatly improved. The specific situation is shown in Figure 5.

5. Conclusion

Big data and the Internet of Things are developing rapidly in a fast and irreversible trend. The application of big data has also shown the broad prospects of big data and the Internet

of Things. My country's application of new technologies such as big data and Internet of Things is seen in various industries. The road of policies has been paved, and the continuous development of information technology has also achieved resource sharing and collaborative work. Currently, it has become a trend to apply big data and Internet of Things technologies to various industries. With the popularization of the Internet and smart devices, more and more social networks, the advent of the era of big data is becoming more and more obvious, which will undoubtedly become a new development trend of tourism. With the progress of my country's economy and science and technology, my country's tourism has been significantly developed. The development of tourism resources and the tourist experience of tourists cause bad reflections, most of which are caused by tourists' failure to plan well in advance. Today, with the rapid development of information technology, the technology + industry application model has been widely used in various fields in my country, and the way of cultural publicity should also adapt to the trend so that the culture of various tourist destinations can be promoted faster and more widely on the Internet. The application of the Internet has effectively broken the time and space constraints in the process of information dissemination. The use of Internet-related technologies to promote tourist destinations can not only inherit and expand the culture of tourist destinations but also attract more foreign tourists, thus promoting the deep integration of local cultural tourism industries. Combining big data and Internet of Things technology for publicity and marketing can further improve the popularity and digital construction of the cultural tourism industry and ultimately benefit all tourism companies. By designing a questionnaire survey and using statistical methods to analyze the data obtained from the questionnaire, this paper summarizes the problems existing in the innovation and digital construction of the current cultural tourism industry, mainly including the feeling that tourists cannot experience the deep integration of culture and tourism, and the strength of marketing and publicity. Insufficient and low level of digital construction make it unable to complete personalized recommendation and result in proposing innovative strategies, mainly including combining big data and the Internet of Things to provide tourists with an immersive travel experience, integrating new technologies to enhance marketing and publicity efforts, and combining big data technology for personalized service recommendations, in order to provide incremental contributions to the healthy development and digital construction of the cultural tourism industry.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

Acknowledgments

This paper is one of the phased achievements of Heilongjiang Oriental University's general project: Research on Internationalization Strategy of National Brands under the Background of "the belt and road initiative" (HDFKY210215), and the key project of the 14th Five-Year Plan of Education Science in Heilongjiang Province, Research on Interactive Teaching Mode and Application of Online Courses from the Perspective of Cognitive Load (GJB1422479).

References

- [1] V. Chang, X. Q. Li, J. Q. Zhang, Q. W. Xu, and R. F. Valverde, "Brand personality in cultural tourism and sustainable development by using big data analytics," *International Journal of Business and Systems Research*, vol. 16, no. 1, pp. 125–139, 2022.
- [2] F. Fang and T. X. Chen, "Research on big data mining of cultural connotations of Chengdu cultural tourism project," *Scientific Journal of Humanities and Social Sciences*, vol. 3, no. 10, 2021.
- [3] M. Konstantakis, A. Georgios, and C. George, "A Personalized Heritage-Oriented Recommender System Based on Extended Cultural Tourist Typologies," *Big Data and Cognitive Computing*, vol. 4, no. 2, p. 12, 2020.
- [4] J. M. Lin, "Research on technology framework of simulation virtual navigation multi-line system based on big data for characteristic culture tourism," *International Journal of Applied Mathematics and Soft Computing*, vol. 4, no. 2, 2018.
- [5] Y. R. Zhang, Z. Y. Tang, and G. X. Sun, "Cross-Modal travel route recommendation algorithm based on internet of things awareness," *Journal of Sensors*, vol. 2021, Article ID 5981385, 11 pages, 2021.
- [6] L. Ding and Y. Z. Liang, "Cloud computing and internet of things in the evaluation of ecological environment quality in rural tourist areas in smart cities," *Mobile Information Systems*, vol. 2021, Article ID 6295568, 11 pages, 2021.
- [7] X. D. Guo, Y. X. Wang, J. Q. Mao, Y. M. Deng, F. T. S. Chan, and J. H. Ruan, "Towards an IoT enabled tourism and visualization review on the relevant literature in recent 10 years," *Mobile Networks and Applications*, vol. 27, pp. 1–14, 2021.
- [8] Z. Lv, D. Chen, and H. Lv, "Smart city construction and management by digital twins and BIM big data in COVID-19 scenario," *ACM Transactions on Multimedia Computing Communications and Applications*, 2022.
- [9] J. Chen, Q. Wang, J. Huang, and X. Chen, "Motorcycle ban and traffic safety: evidence from a quasi-experiment at zhejiang, China," *Journal of Advanced Transportation*, vol. 2021, Article ID 7552180, 13 pages, 2021.
- [10] X. Zhang, "Characteristics of mountain climate change and optimization of agricultural tourism management based on satellite Internet of Things," *Arabian Journal of Geosciences*, vol. 14, no. 16, 2021.
- [11] D. Yu, Z. Ma, and R. Wang, "Efficient Smart Grid Load Balancing via Fog and Cloud Computing," *Mathematical Problems in Engineering*, vol. 2022, no. 4, Article ID 3151249, 11 pages, 2022.
- [12] D. Yu, J. Wu, W. Wang, and B. Gu, "Optimal performance of hybrid energy system in the presence of electrical and heat storage systems under uncertainties using stochastic p-robust

Retraction

Retracted: Infrastructure Smart Service System Based on Big Data Information System

Mobile Information Systems

Received 7 November 2022; Accepted 7 November 2022; Published 22 November 2022

Copyright © 2022 Mobile Information Systems. 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.

Mobile Information Systems has retracted the article titled “Infrastructure Smart Service System Based on Big Data Information System” [1] due to concerns that the peer review process has been compromised.

Following an investigation conducted by the Hindawi Research Integrity team [2], significant concerns were identified with the peer reviewers assigned to this article; the investigation has concluded that the peer review process was compromised. We therefore can no longer trust the peer review process, and the article is being retracted with the agreement of the Chief Editor.

References

- [1] D. Wang, “Infrastructure Smart Service System Based on Big Data Information System,” *Mobile Information Systems*, vol. 2022, Article ID 9261023, 12 pages, 2022.
- [2] L. Ferguson, “Advancing Research Integrity Collaboratively and with Vigour,” 2022, <https://www.hindawi.com/post/advancing-research-integrity-collaboratively-and-vigour/>.

Research Article

Infrastructure Smart Service System Based on Big Data Information System

Wang Dou 

Department of Engineering Management, Sichuan College of Architectural Technology, Deyang 618000, Sichuan, China

Correspondence should be addressed to Wang Dou; douwang@scac.edu.cn

Received 10 May 2022; Revised 22 June 2022; Accepted 8 July 2022; Published 30 July 2022

Academic Editor: Amit Gupta

Copyright © 2022 Wang Dou. 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 acceleration of urbanization and the improvement of people's living standards, people pay more and more attention to the services provided by infrastructure. Smart services refer to the services provided by individuals or organizations using their wisdom for other people or organizations to facilitate people's lives. Wisdom is not only a tool of service but also the content of service. In fact, the rapid economic development and infrastructure construction did not develop in equal proportions. With the continuous progress of society, groups with different social attributes have emerged, and they have put forward diversified demands for public services in terms of both quality and quantity. This paper aims to study the research of infrastructure intelligent service system based on big data information system. It expects to use the big data information system to integrate the current infrastructure resources to meet people's needs. Big data refer to a large amount of diverse digital information that requires new processing modes to have higher decision-making power. This paper designs and develops a new smart community service system, hoping to provide people with more and more convenient services through this system. This paper explores public facilities services from the perspective of public facilities stakeholders to realize the value transformation of public facilities. The experimental results of this paper show that 67% of the people participating in the experiment believe that the protection of stair treads is very necessary, and 73% of people think that it is very necessary to install elevators in multistorey residences. According to the data, most consumers believe that smart services are very necessary and need to be equipped.

1. Introduction

As living standards improve, people's demands for infrastructure increase. Coupled with the advancement of science and technology, the technical content of infrastructure is getting higher and higher. This brings great convenience to people. Although the construction of infrastructure is currently attached great importance, the current infrastructure smart services still face many difficulties. For example, the cost of renovation is too high, the base of community residents is huge, and the time cannot be accurately grasped. It lacks a unified business system, there is no conclusion on how to establish a matching business process, and talent support is lagging behind. This paper aims to study the research of infrastructure intelligent service system based on big data information system. It expects the Amex big data

information system to integrate the current infrastructure resources to meet people's needs.

The construction of smart infrastructure creates conditions for optimizing and facilitating the travel of citizens. It proposes the public facility service design principles and public facility service design strategies based on stakeholders. This provides a certain theoretical support for the transformation of public facilities design to public services in the context of smart cities. As the foundation and necessary condition for economic and social development, infrastructure can save energy and add stamina for development. The lag in construction may become a bottleneck restricting development.

This paper explores the infrastructure intelligent service system. With the help of the big data information system, an investigation was carried out on the infrastructure situation

of the community in place A. From the perspective of the configuration of smart service supporting facilities, according to the survey data, 14% is equipped with elderly universities, and 81% is equipped with night lighting facilities. According to the data, the number of older universities is relatively small, and other infrastructures are more complete. Judging from the demand for various smart services, the demand rate of community hospitals is 62%. The demand rate of night lighting service was 62%, indicating that these two services are indispensable equipment for the community.

2. Related Work

With the improvement of the level of science and technology, more and more technological elements are integrated into life. Infrastructure services are the most common area. So far, there have been setbacks in choosing technical solutions relevant to local needs due to underestimation of the cost of technical solutions. It encounters a large number of incompatibilities between protocols and appropriate solutions, and utilities and suppliers have real problems. Zabasta et al. presented the study of creating a smart municipal system architecture in a local service cloud applying SOA and IoT approaches. He developed an application orchestration service and a proxy that resides on the gateway. Application Orchestration Service (AOS) can help people deploy applications to HUAWEI CLOUD with one click and simplify related cloud service management operations. The proxy provides adapter and protocol conversion functions. It also applies a tool that connects hardware devices, APIs, and online services [1]. The concept of infrastructure intelligent service system is proposed based on digital technology and the comprehensive construction and maintenance of infrastructure. Zhu et al. gave the definition of iS3. iS3 is an intelligent service system designed for integrated lifecycle data acquisition, processing, presentation, analysis, and infrastructure services. The goals and characteristics of iS3 are then displayed, indicating the relationship to existing systems such as BIM and GIS. iS3 consists of five layers, namely base layer, data layer, service layer, application layer, and user layer. In addition, iS3 is described in detail from the perspective of data acquisition, processing, presentation, analysis, and services [2]. Grisot *M* studied infrastructure in the context of the development of a national public e-health service in Norway. He worked on the design and development of new online communication capabilities between citizens and primary care physicians. It defines this case as an infrastructure redesign study to represent a specific infrastructure event. It requires the promotion of new logic in social networks and established technologies. To understand the peculiarities of reconstruction, it relies on research in infrastructure research. The study views embeddedness as a resource in the evolution of infrastructure. Infrastructure is proactive and fundamental. It is nontradable, integrally indivisible, and quasipublic goods. The provision of services or the provision of efficient infrastructure can only be achieved when infrastructure reaches a certain size [3]. Infrastructure development

depends on resource allocation. It is often an imbalance between cities. Socioeconomic instability stems from this development gap, which affects decision-making processes focused on sustainable development. Rana et al. proposed a method for examining the time dynamics of infrastructure development gaps at various spatial scales. From the selection of spatial scales, time series and infrastructure development indicators suitable for the research requirements, the values of the Infrastructure Development Index (IDI) are calculated using sequential steps that include data normalization and evaluation of indicator weights using AHP. Segment, IDI, and variance analyzes were then performed using different coefficient (C_v) methods, changing the IDI time values and the C_v test/sample t -test, respectively. The results show that the proposed method works well in identifying growth gaps at different spatial scales [4]. Although these theories discuss infrastructure construction, they are not perfect in data processing. This paper combines infrastructure construction with big data technology, hoping to solve this problem.

The promotion of Internet of Things technology has made the application of big data more and more extensive. Wang and Chen analyzed the legal framework of agricultural investment by Chinese enterprises in the context of big data. In big data method analysis, decision support systems are used to analyze policies, even in conflict with multiple entities and their problems, to choose the best judgment. At the same time, in the context of Big Data, based on an in-depth reflection on the history, status quo, problems, and institutional roots of the agricultural investment legal system, the experience and lessons learned of foreign agricultural investment legal systems complementary. From the point of view of economic law, it carries out a systematic analysis of the legal system of agricultural investments. Finally, through the analysis of the problems, it puts forward proposals for decision-making in agricultural investments, which refer to the following relevant studies [5]. Jia has provided an in-depth understanding and analysis of English teaching reform in colleges and universities through in-depth research and analysis of the role of Big Data technology in reform. Based on the background of the educational information age, this study examines the transformative value of integrating information technology and teaching activities. It also extends its relative implications to both theoretical and practical levels. The field of information technology integration and teaching technology activities and its transformative value are at the heart of the research. The integration of information technology and teaching activities is not only a simple overlay of information technology and teaching but also a process of exploring the role and impact of information technology in teaching activities through an in-depth investigation of the internal relationship between the two. It then completes the combination of information technology and teaching activities and finally realizes the complete development of the students' personality [6]. Because data are generated by a variety of devices in a short period of time, this data are characterized by different forms of storage and is generated quickly. This can be seen to a large extent as a big data problem. In order

to provide a more convenient health and environment service, Zhang et al. has proposed a cyberphysical system for patient-centered applications and services based on cloud and big data analytics technologies. The system consists of a unified standard data acquisition level, a data management level for distributed storage and PCs, and a data-driven service level. The results of this study suggest that cloud and big data technologies can be used to improve the performance of healthcare systems [7]. The growing popularity and development of data mining technology have posed a serious threat to the security of sensitive personal information. The data mining process is an iterative process. If each step does not achieve the expected goal, it needs to go back to the previous step, readjust, and execute. In recent years, an evolving research topic in data mining, known as offset data mining (PPDM), has been extensively researched. Xu et al. has taken a broader perspective on data mining-related privacy issues and has explored various methods that help protect sensitive information. In this way, data mining algorithms can be executed efficiently without compromising the security of sensitive information contained in the data and can reduce the privacy risks posed by data mining functions [8]. Although these theories describe big data, they are not linked to infrastructure and are not practical.

3. Infrastructure Smart Service System of Big Data Information System

3.1. Public Infrastructure. With the acceleration of urbanization, the demand for urban infrastructure is also increasing. With the improvement of living standards, people's requirements for infrastructure are getting higher and higher [9, 10]. Public infrastructure is often referred to as public facilities, which evolved from the concept of urban home. The facilities and utensils that people will place in public places for public use are collectively referred to as public facilities [11]. Public infrastructure refers to some infrastructure that is set up for the public and can be shared by the public and is not allowed to be monopolized or exclusive by one person such as medical institutions, educational institutions, roads, and bridges. In the early stage of urban development, people paid more attention to the overall development of the city and paid less attention to the design of public spaces. But over time, people's way of life and ideas have changed. People are more and more dependent on public facilities, and social activities are becoming more and more complex, so the planning of public facilities is becoming more and more refined [12, 13].

In fact, the development level of public facilities reflects the comprehensive strength of the country. At the same time, different countries and regional cultures will have an impact on the local infrastructure construction [14, 15]. For example, residents of European cities prefer the outdoors. In addition, the governments of European countries continue to guide citizens to travel green and live in an environmentally friendly manner based on the sustainable construction of green development. Therefore, most European countries have bicycle lanes and associated facilities on the road. Judging from the design of public facilities in Asia,

Japan is very concerned about humanization, and it can even be said that the concept of humanized design runs through all aspects of Japanese design [16]. Figure 1 shows its humanization in transportation.

China's infrastructure is very differentiated, with more technological elements integrated in places with a higher level of economic development. When a city has a strong historical and cultural heritage, its public facilities will have obvious cultural characteristics [17, 18]. However, with the development of science and technology, information technology service facilities bring more and more convenience to people, so such facilities are becoming more and more popular [19]. For example, new public facilities such as fast-charging piles for mobile phones at stations and smart bus stops with real-time information display are more in line with current needs and are more popular. Generally speaking, China has gone through different stages in the design of public infrastructure, which is illustrated using Figure 2:

3.2. Big Data Algorithms. With the promotion of Internet technology, more and more information appears together in life [20]. Although more information means more information can be found, too much information makes it impossible for people to accurately find the information they need and solve problems efficiently. In order to make better use of various information, it is necessary to preprocess the data. Figure 3 shows the brief processing structure of the data:

$$Y_a = \sum_y^p \sum_p^p |h_y - f_r|^3. \quad (1)$$

Formula (1) represents the data initialization structure. During data cluster analysis, data are divided into different categories. y represents the number of clusters.

$$Y_r = \sum_y^a t_y u * y. \quad (2)$$

In formula (2), $u * y$ represents the distance between data. When y is smaller, it means that the objects of the data are more concentrated.

$$u * y = \frac{4}{o_y(o_y - 2)} \sum_i \sum_l \|u - u'\|^4. \quad (3)$$

Among them, o_y represents the number of objects in the data category. When the number is larger, the distance between the data is smaller.

$$SSE = \sum_f^h \sum_g^g l(g_f, a)^3. \quad (4)$$

Data are divided into different types during data analysis. The error sum of squares is usually used as the objective function to measure the clustering quality.

$$\text{Cov}(W, T) = \frac{\sum_u^o (W_u - W)(T_u - T)}{o - 1}. \quad (5)$$



FIGURE 1: Humanization of transportation.

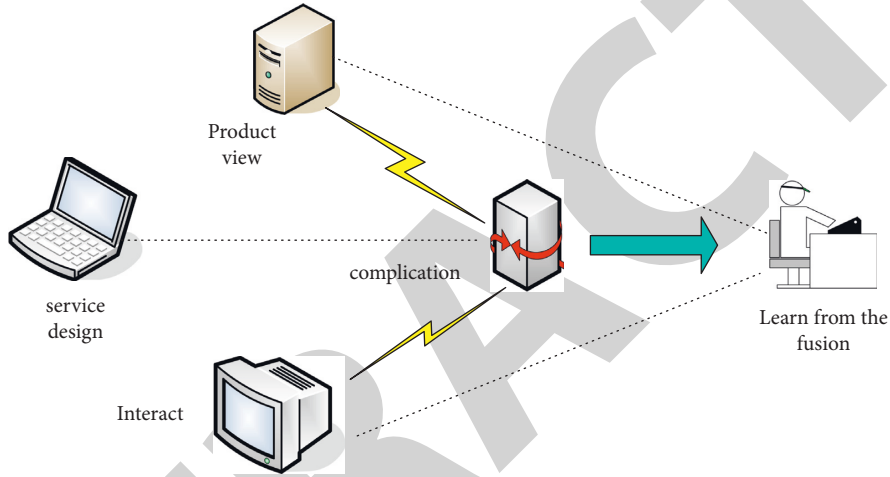


FIGURE 2: Concepts of different stages of infrastructure construction.

Formula (5) represents the covariance. It is usually used to calculate the overall error of the data.

$$G_{a,b} = \frac{P_{a,b}}{P_a P_b}. \quad (6)$$

Formula (6) represents the correlation coefficient of the data. It is often used to compare the closeness between data. Among them, P_a and P_b represent the standard deviation of the sample.

$$\text{cutoff} = 2 - \frac{QT}{QW}. \quad (7)$$

Formula (7) represents the truncation ratio of the algorithm operation, where QT represents the number of data clustering, and QW represents the number of clustering in the evolutionary process.

$$QW = \frac{YU}{BN}. \quad (8)$$

Among them, YU represents the maximum evolutionary algebra, and BN represents the population clustering interval algebra.

$$\text{centre}_h = \frac{\sum_o^u G_{kl}}{p}. \quad (9)$$

Among them, center_h represents the total number of data clusters, G_{kl} represents the components in the data set, and p represents the number of cluster centers.

$$l(u) = \sqrt{\sum_o^f \sum_k^b (p_{cd} - s_{cd})^3}. \quad (10)$$

Formula (10) represents the Euclidean distance of all objects to the cluster center.

$$\begin{aligned} Q(1) &= Q(h(a)) \\ &= \frac{1}{k} \sum_1^k h(a_1). \end{aligned} \quad (11)$$

Among them, $h(a)$ is an unbiased estimate of Q .

$$\beta(a) = \frac{w(a) = w_1(a_1)w_2(a_2|a_1) \cdots w_c(a_c|a_1 \cdots a_c)}{y(a) = y_1(a_1)y_2(a_2|a_1) \cdots y_c(a_c|a_1 \cdots a_c)}. \quad (12)$$

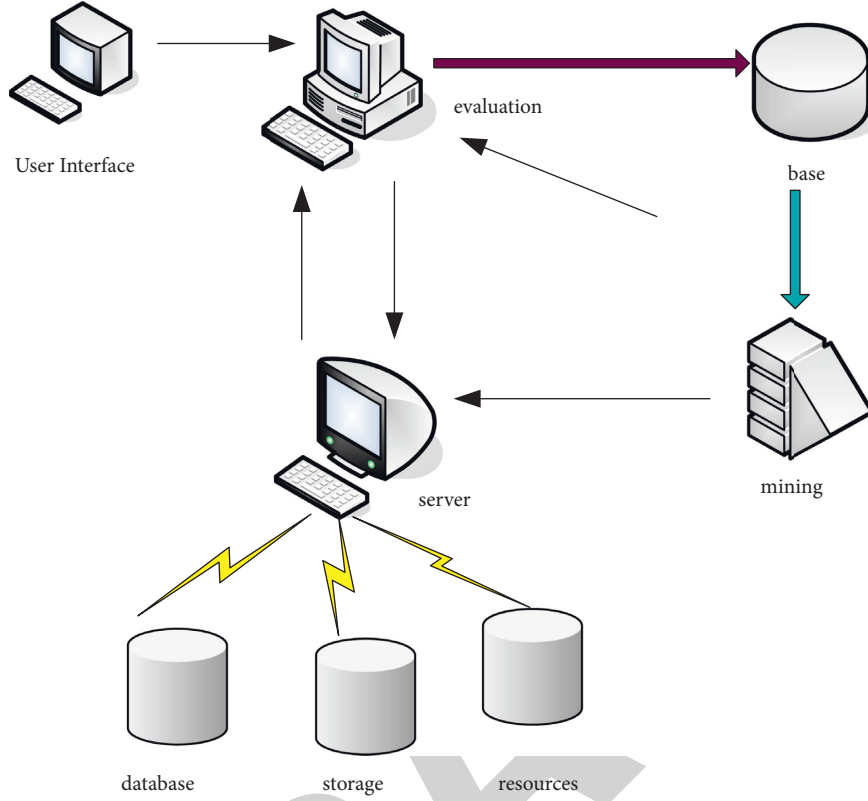


FIGURE 3: Data information processing structure.

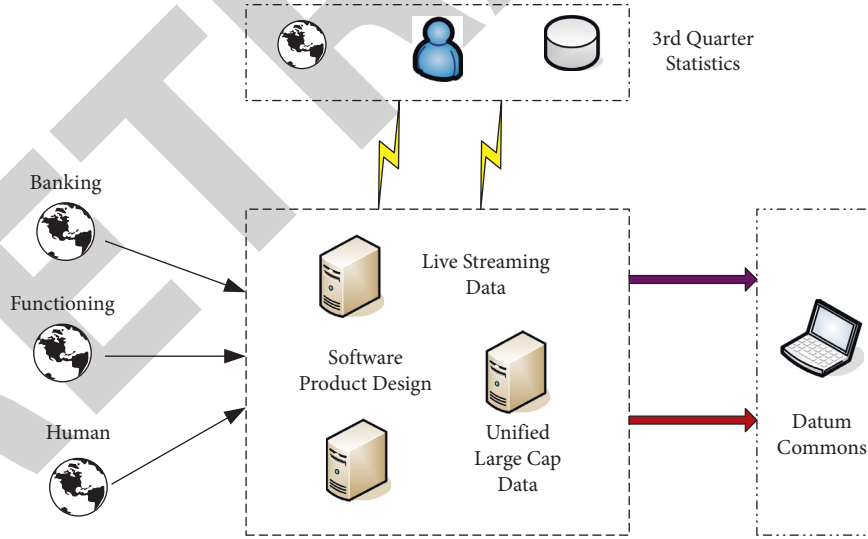


FIGURE 4: Basic structure of information sharing in the whole system.

In order to analyze the data objectively, the data need to be analyzed in detail. It compares one-level elements two by two for quantitative description:

$$W = (w_{op})$$

$$= \begin{bmatrix} w_{11} & w_{12} & \cdots & w_{1k} \\ w_{21} & w_{22} & \cdots & w_{2k} \\ w_{31} & w_{32} & \cdots & w_{3k} \end{bmatrix}. \quad (13)$$

Formula (13) represents the judgment matrix function expression.

$$\text{New_}R(U, C_s) = \sum_c \frac{|U_l|}{|U|} R(U_l). \quad (14)$$

Formula (14) represents the functional expression of the information entropy of the subtree, and U_l represents the attribute feature of the sample.

For mixed feature datasets, it needs to be handled in a different way.

$$D_s(O_i, O_j) = \sum_{k=1}^m \frac{n_{h_{ik}} + n_{h_{jk}}}{n_{h_{ik}} \cdot n_{h_{jk}}} \sigma(x_{ik}, x_{jk}). \quad (15)$$

Among them, x_{ik} and x_{jk} are the corresponding k th of o_i and o_j ($1 \leq k \leq m$). $n_{h_{ik}}$ and $n_{h_{jk}}$ are the number of h_{ik} and h_{jk} for attribute h_k in the dataset, respectively. Figure 4 shows the basic structure of information sharing throughout the system:

$$D(O_i, O_j) = \mu D_s(O_i, O_j) + D_n(O_i, O_j). \quad (16)$$

Among them, μ is the weight of the adjustable character attribute, and $D_n(O_i, O_j)$ is the Euclidean distance of n numerical attributes.

$$\beta'' \in \left(f_u - \|\beta\| * \left(\frac{\eta}{3}\right), f_u + \|\beta\| * \left(\frac{\eta}{3}\right) \right). \quad (17)$$

Formula (17) represents the shrinking sampling space of the data. Among them, u represents the attribute, and $\|\beta\|$ represents the original value length of the attribute.

$$\frac{\text{Var}(T_a)}{\text{Var}(W_a)} \geq 2 + \left(G\phi + \frac{G^3\phi^3}{\phi} \right). \quad (18)$$

ϕ represents the smoothing coefficient, and $0 < \phi < 1$.

$$\frac{\text{Var}(T_a)}{\text{Var}(W_a)} \geq 2 + \left(\frac{G}{c} + \frac{3G^3}{c^3} \right). \quad (19)$$

At this point, the variance of the function is in an independent distribution state.

$$W_2 = \frac{Q_3}{Q} \left(- \sum_k^n \frac{Q_{3i}}{Q_3} \log_2 \frac{Q_{3i}}{Q_3} \right). \quad (20)$$

Among them, $3i$ represents the number of classifications, and the values obtained at this time are all approximate information gain values. In probability theory and information theory, information gain is asymmetric and used to measure the difference between two probability distributions P and Q . Information gain describes the difference between coding with Q and coding with P .

3.3. Big Data Information System. Big data is one of the hot topics of the moment. As we all know, the essence of big data lies not in the scale of data, but in the increasing amount of data that can be utilized, processed, and analyzed by people. Through the analysis and mining of these data, people can gain insight into new laws, acquire new knowledge, and create new values. The big data processing process mainly includes data collection, data preprocessing, data storage, data processing and analysis, data display/data visualization, data application, and other links. Big data is not just data but also a capability and resource. It is the ability to deduce information from simple data resources and sublimate information into knowledge. Simply put, big data is the ability to quickly obtain valuable information from various data.

With the continuous development of computer technology, the concept of big data has gradually emerged. Although big data has been used in many fields, there is currently no internationally recognized concept. Big data has its own unique understanding in various fields. For example, some scholars believe that big data refers to the scale of data sets involved that has exceeded the ability of traditional database software to acquire, store, manage, and analyze. Regardless of the definition of big data in various fields, it cannot be denied that people are now in the era of big data, and their surroundings are closely related to big data. Figure 5 shows the basic structure of the big data system:

As an innovative technology, big data continue to lead the transformation of the industry. However, the combination of urban planning and big data is still in its infancy. Although the application of big data in the urban planning industry has been explored for several years, the application of big data in research on public service facilities is rare. There are still many problems with the combination of the two, for example, there is a lack of effective communication between users, maintainers, and managers of public facilities. The damage and failure information of public facilities cannot be obtained. The design of public facilities is mostly based on the subjective assumptions of planning decision-makers. It lacks access to the deep needs of users of public facilities. Figure 6 is a schematic diagram of infrastructure construction under the blessing of big data technology:

4. Infrastructure Smart Service System Experiment

4.1. Exploration of Experimental Objects. Infrastructure is the necessary material basis for social production and life. With the development of society and economy, people's living standards are getting higher and higher, and the requirements for the infrastructure of communities and cities are also getting higher and higher. Different social roles living in cities view infrastructure differently. In order to talk about the views of different people, a survey was carried out on citizens of different identities. The details are shown in Table 1;

According to the data in Table 1, the questionnaire survey method was used to analyze the community infrastructure. According to the survey data, there are 133 men in the survey group, accounting for 44.3%. There are 173 women, and the proportion is 57.3%. It can be seen from the data that the difference between the proportions of men and women is small, and the sample is more scientific. Judging from the age of the respondents, there are 57 people between the ages of 17 and 25, accounting for 19%; There are 96 people aged 26–37, which is 32%. There are 117 people aged 38–47, which is 39%. There are 30 people over 47 years old, and the proportion is 10%. According to the revised data, the number of people aged 26–47 is the largest. Most of the people in this group are labor groups, and they have more say in the level of local infrastructure services, and their views are more valuable.

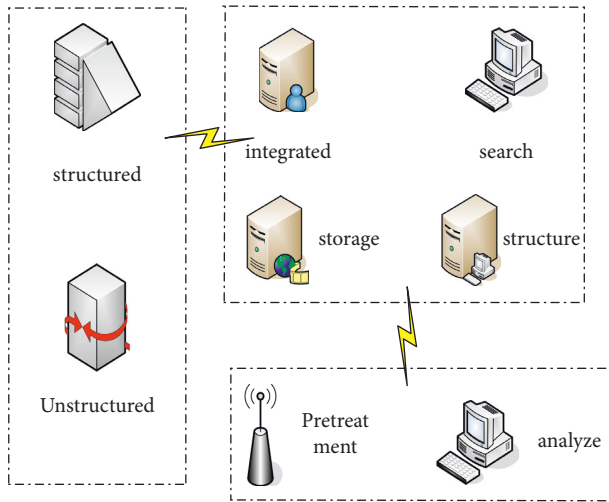


FIGURE 5: Flow chart of the big data work phase.

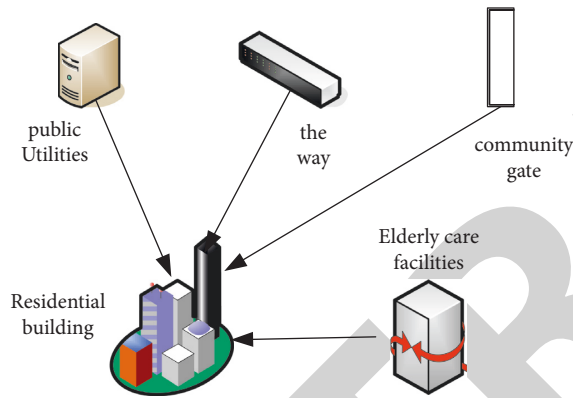


FIGURE 6: A simplified diagram of infrastructure construction under the blessing of big data technology.

TABLE 1: Analysis of the basic situation of the experimental subjects.

| Item | No. | Category | Number of people | Proportion |
|--------|-----|------------------------|------------------|------------|
| Gender | 1 | Male | 133 | 44.3 |
| | 2 | Female | 173 | 57.7 |
| Age | 1 | 17–25 years old | 57 | 19 |
| | 2 | 26–37 years old | 96 | 32 |
| | 3 | 38–47 years old | 117 | 39 |
| | 4 | More than 47 years old | 30 | 10 |

According to the data in Table 2, the occupation of the people who participated in the survey was investigated. According to the data, there are 12 employees in state-owned enterprises, and the proportion is 4%. There are 67 employees in private enterprises, which is 22.4%. There are 27 full-time technical personnel, accounting for 9.2%. There are 61 service staff, and the proportion is 20.3%. There are 24 workers, which is 8%. There are 9 agricultural production personnel, accounting for 3%. There are 39 unemployed persons, accounting for 13%. There are 60 other personnel,

accounting for 20.1%. According to this data, staff at all levels of the investigators are involved. The data obtained are more realistic and in line with the purpose of this survey.

4.2. Investigation on the Educational Level of the Experimental Subjects. An individual's perception of infrastructure is related to an individual's experience. People with different educational backgrounds have different views on the same infrastructure. People with higher education have a more multifaceted view of infrastructure and will not draw conclusions on one aspect, but the overall level of facilities is higher. People with lower education have lower overall effect on the facility, but it is easy to draw conclusions from one aspect. In order to investigate the local infrastructure, the educational background of the people who participated in the investigation was analyzed. The details are shown in Table 3:

According to the data in Table 3, it can be seen that the educational background of the surveyed subjects has been classified differently. According to the survey, there are 24 investigators with a master's degree or above, accounting for 8%. There are 69 people with a bachelor's degree, and the proportion is 23.1%. There are 55 people with college degree or above, the proportion is 18.4%; There are 97 people with high school education and above, and the proportion is 32.4%. There are 51 people with junior high school education and below, and the proportion is 18.1%. According to the distribution of educational backgrounds of the investigators, the number of persons with a high school education or above is the largest. It shows that there are more respondents with lower-educational level, and 31% of them have higher-educational level. From this, it can be seen that in the survey group, there are a certain proportion of the number of people at each educational level, and the information obtained is more realistic.

4.3. Annual Income Level. The annual income level refers to the salary level of an individual in a year. Groups at different salary levels have different perceptions of local infrastructure. When the personal salary level is higher, there will be higher requirements for the local infrastructure. Individuals have different perceptions of infrastructure as they play different roles in society.

According to the data in Table 4, the social roles and family income of the investigators were analyzed. First of all, from the perspective of social roles, there are 100 people in this part of the group, of which there are five people in the management part, and the proportion is 11%. There are 21 people in the design unit, and the proportion is 41%. There are 24 people in the organizer, and the proportion is 48%. According to the data, people from various departments are involved, the collected results are more diversified, and the data are more real.

Judging from the family income of the investigators, there are 54 people with family income between 10,000 and 20,000, accounting for 18%. There are 132 people with family income between 20,000 and 70,000, and the proportion is 44%. There are 60 people with household income between

TABLE 2: Occupational composition survey.

| Item | No. | Category | Number of people | Proportion |
|--------|-----|--------------------------------------|------------------|------------|
| Career | 1 | Employees of state-owned enterprises | 12 | 4 |
| | 2 | Private company staff | 67 | 22.4 |
| | 3 | Professional and technical staff | 27 | 9.2 |
| | 4 | Service workers | 61 | 20.3 |
| | 5 | Workers | 24 | 8 |
| | 6 | Agricultural production workers | 9 | 3 |
| | 7 | Unemployed | 39 | 13 |
| | 8 | Others | 60 | 20.1 |

TABLE 3: Analysis of the survey on the education of the masses participating in the survey.

| Item | No. | Category | Number of people | Proportion |
|-------------------------|-----|------------------------------|------------------|------------|
| Academic qualifications | 1 | Master or above | 24 | 8 |
| | 2 | Bachelors | 69 | 23.1 |
| | 3 | College and above | 55 | 18.4 |
| | 4 | High school and above | 97 | 32.4 |
| | 5 | Junior high school and below | 51 | 18.1 |

TABLE 4: Household income and social role survey.

| Item | No. | Category | Number of people | Proportion |
|--------------|-----|----------------------|------------------|------------|
| Social role | 1 | Management | 5 | 11 |
| | 2 | Design unit | 21 | 41 |
| | 3 | Contractor | 24 | 48 |
| Income level | 1 | 1–2 million | 54 | 18 |
| | 2 | 20–70,000 | 132 | 44 |
| | 3 | 70–120,000 | 60 | 20 |
| | 4 | Greater than 120,000 | 66 | 22 |

70,000 and 120,000, and the proportion is 20%. There are 66 people with a household income of more than 120,000 yuan, and the proportion is 22%. According to the data, people from all income groups are involved in the survey group, and the survey object has a wide range. The information collected comes from different classes, and the data is more authentic. This is more conducive to reflecting the local infrastructure situation, and the view of local infrastructure is more objective.

5. Infrastructure Smart Service System

5.1. Infrastructure Configuration. With the development of economy, people's requirements for life are getting higher and higher. This requires the surrounding infrastructure to be more complete. In order to explore the local infrastructure configuration, a brief survey was conducted on the infrastructure of the local elderly living places, and the local residential facilities were analyzed. The specific situation is shown in Figure 7:

According to the data in Figure 7, a survey was conducted on the local elderly's tendencies and places for retirement, as well as the local smart infrastructure configuration. First of all, 80 volunteers who participated in the survey were surveyed from the perspective of the elderly's tendencies to care for the elderly at that time. Among

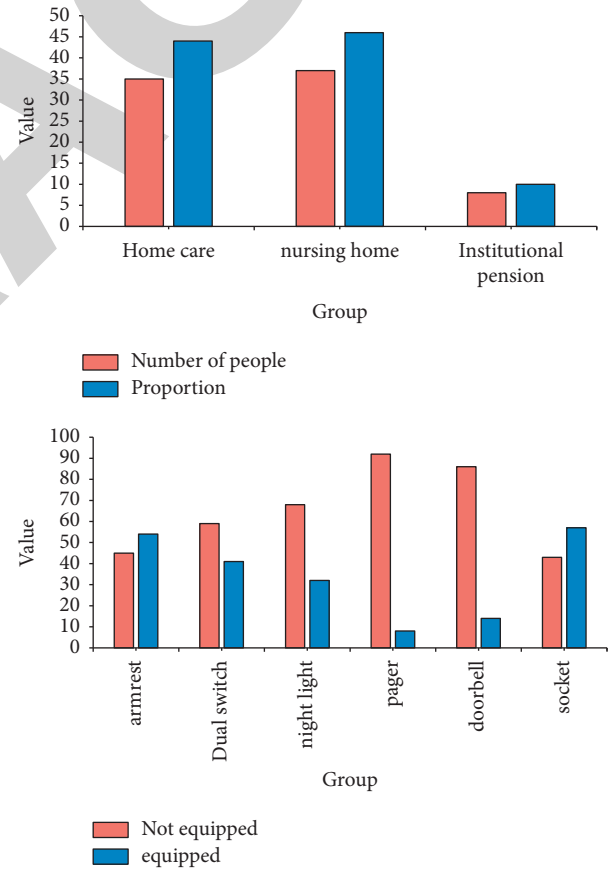


FIGURE 7: Elderly people's retirement preference and smart infrastructure deployment.

them, 35 people want to live at home, the proportion is 44%. A total of 37 people want to retire in the community, the proportion is 46%. A total of 8 people want to retire in institutions, and the proportion is 10%. According to the data, there are more people who want home-based care and community-based care, except for personal family reasons. It

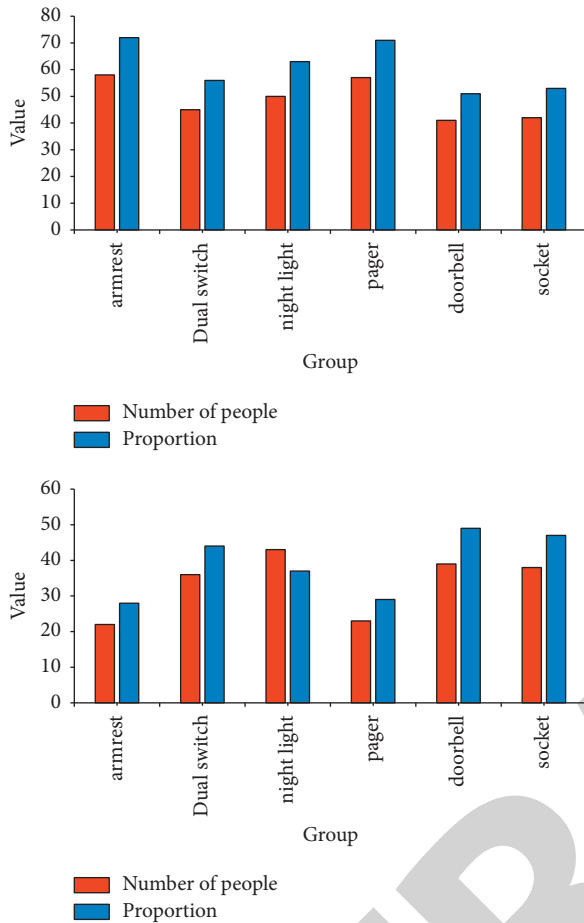


FIGURE 8: Analysis of the needs of the elderly for interior design and intelligent facilities.

can also show that the infrastructure of the community is getting more and more complete, and people can also enjoy high-quality services in the community.

From the perspective of local infrastructure smart services, 54% of the surveyed groups reported that there are enough handrails in the local area. A total of 45% of people report that the local handrails are not adequate. A total of 59% of people reported that the local area is equipped with dual-control switches. A total of 41% of people reported that the local area is not equipped with dual-control switches. A total of 32% of people reported that the local area has night lights. A total of 68% of people reported that the local area is not equipped with night lights. A total of 8% of people reported that the local area is equipped with a pager. A total of 92% of people report that the local area is not equipped with a pager. A total of 14% of the people reported that the local area is equipped with a smart doorbell, and 86% of the people reported that the local area is not equipped with a smart doorbell. A total of 57% of the people reported that there are sockets in the local area, and 43% of the people reported that there are no sockets in the local area. According to the data, in these infrastructures, except for pagers and smart doorbells, other facilities are relatively complete. But there are

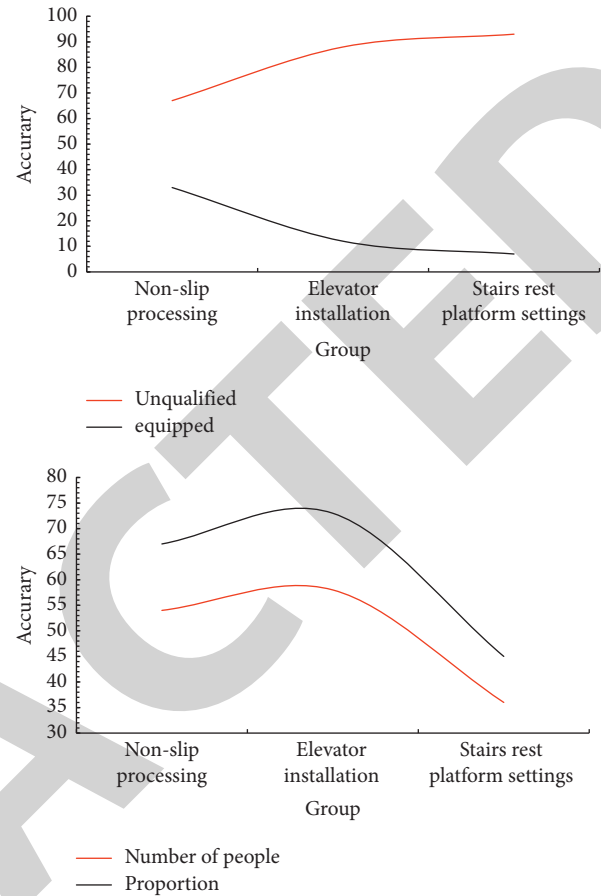


FIGURE 9: Analysis of leisure intelligent infrastructure.

still some communities that have not been installed. To explore consumer demand for these devices, the perceptions of the respondents were analyzed.

According to the data in Figure 8, the needs of local consumers have been explored and analyzed. First of all, from the perspective of the need for smart services provided by these infrastructures, 58 people think that they need to be equipped with sufficient handrails, and the proportion is 72%. For the elderly, handrails are needed, which can help the elderly provide physical support. Forty-five people believe that dual-control switches are needed, and the proportion is 56%. The dual-control switch can provide different services according to the actual user's needs, providing convenience for the actual user. A total of 50 people think that night lights are needed, and the proportion is 63%. Nightlights can provide lighting at night to ensure safety. A total of 57 people think pagers are needed, which is 71%. The pager can call personnel in time and provide help to consumers in time. A total of 41 people believe that a smart doorbell is needed, and the proportion is 51%. Forty-two people think they need sockets, which is 53%. According to the data, most people think that these smart facilities are very necessary. They believe these facilities can help when necessary and reduce danger.

It also investigates from the point of view that smart services are not required. According to the data, only a small

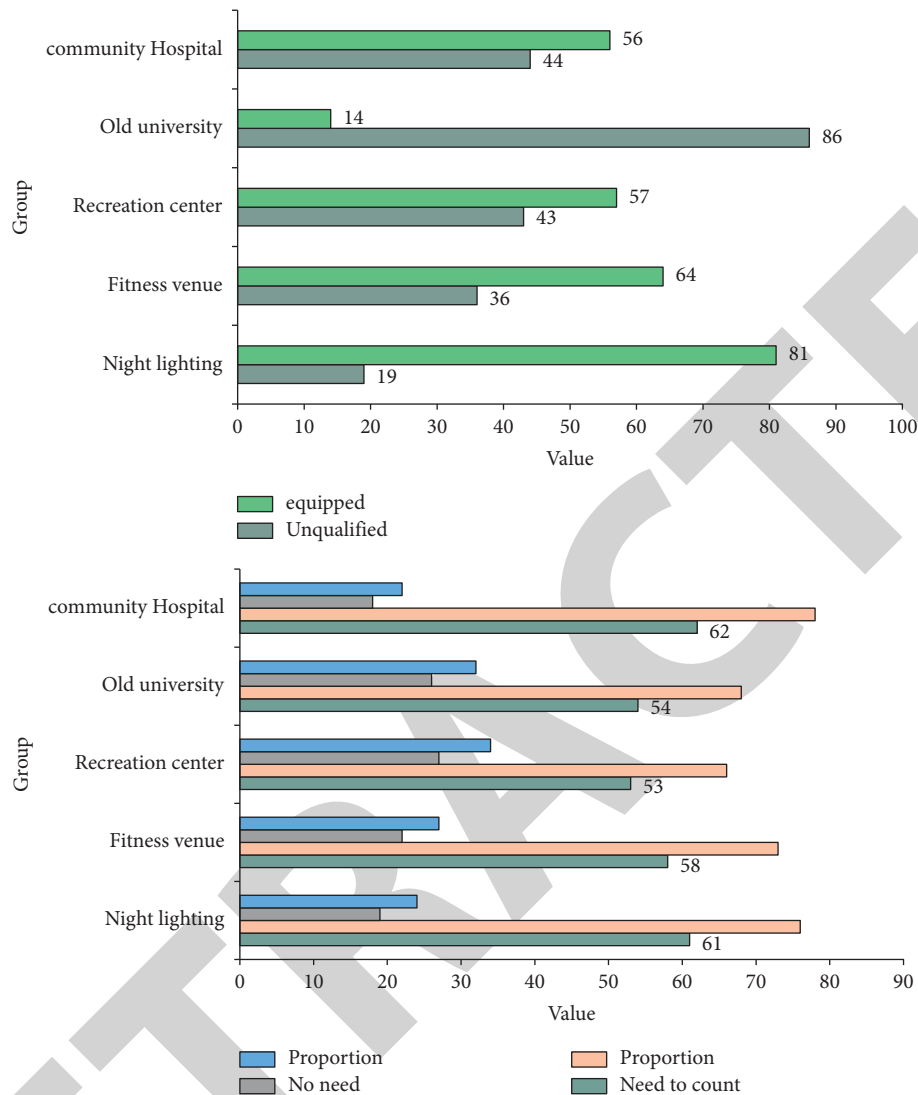


FIGURE 10: Analysis of the preparation of community intelligent supporting facilities.

number of people think these facilities are optional. They believe that in the event of danger, the services provided by these facilities are minimal and cannot bring timely assistance. Moreover, these facilities cost a lot when equipped, and the investment is not proportional to the income, so there is no need to pay too much attention to them. This kind of thinking is wrong. The services provided by smart infrastructure are not to help when harm occurs, but to reduce the probability of harm from the root cause.

5.2. Casual Intelligence Infrastructure. With the progress of the economy, people's living standards continue to improve. The leisure and entertainment facilities in daily life also need to be constantly upgraded. For older people, recreational facilities do not need to be new. Ensuring safety is the most important consideration. In order to explore the local configuration of smart facilities to ensure the safety of the elderly, a survey was conducted on the local configuration. The specific situation is shown in Figure 9:

According to the data in Figure 9, the local security infrastructure was investigated. Among them, only 33% are equipped with stair tread protection treatment, and 67% are not equipped. Only 12% are equipped with multistorey residential elevators, and as high as 88% are not equipped. Only 7% are equipped with stair rest platforms, and as high as 93% are not equipped. According to this data, it can be seen that there are great deficiencies in the antiskid treatment of the stairwell and the configuration of the rest facilities. These smart services need to be provisioned in time to meet consumer demand.

In order to explore the extent of consumer demand for local smart services, a survey was conducted among those participating in the experiment. Among them, 54 people think that the protective treatment of stair treads is very necessary, and the proportion is 67%. A total of 58 people think that it is very necessary to install elevators in multi-storey houses, and the proportion is 73%. A total of 36 people think that the stair rest platform is very necessary, and the proportion is 45%. According to the data, most

consumers believe that smart services are very necessary and need to be equipped.

5.3. Configuration of Intelligent Supporting Facilities in the Community. Complete supporting facilities and consumers are very important. Meeting the diverse living and living needs of the elderly is also inseparable from complete community facilities. In order to analyze the local basic smart service situation, the local infrastructure situation was investigated. The specific situation is shown in Figure 10:

According to the data in Figure 10, first of all, from the perspective of the configuration of smart service supporting facilities, according to the survey data, 56% are equipped with community hospitals. A total of 14% are equipped with older universities. A total of 57% are equipped with entertainment venues. A total of 64% have a fitness center. A total of 81% are equipped with night lighting facilities. According to the data, most other smart services are available except for the elderly universities. Especially the night lighting facilities are basically available in all regions and can provide more complete services at night.

Judging from the demand for various smart services, the demand rate for community hospitals is 62%, and the demand rate for night lighting services is 62%, indicating that these two services are indispensable for the community. From the perspective of the demand for senior colleges, more than half of the people believe that senior colleges are necessary. It can provide the necessary spiritual needs for the elderly, spread antifraud knowledge for the elderly, and reduce the rate of being cheated. In addition, the local people's fitness needs are also large, indicating that people's health awareness is constantly improving.

6. Conclusions

With the advancement of science and technology, people expect science and technology to be linked with life services to provide people with more convenience. With the acceleration of urbanization and the improvement of people's living standards, people pay more and more attention to the services provided by infrastructure. However, the smart services provided by the current infrastructure cannot meet people's needs. This paper aims to study the research of infrastructure intelligent service system based on big data information system. It expects the Amex big data information system to integrate the current infrastructure resources to meet people's needs. Although some achievements have been made in this paper, there are still many shortcomings: the selection of experimental data in this paper is not representative. This data can only represent the status quo of local smart service supply and cannot represent the entire industry.

Data Availability

No data were used to support this study.

Conflicts of Interest

There are no potential competing interests in our paper, and all authors have seen the manuscript and approved to submit to your journal. The authors confirm that the content of the manuscript has not been published or submitted for publication elsewhere.

References

- [1] A. Zabasta, N. Kunicina, and K. Kondratjevs, "Transition from legacy to connectivity solution for infrastructure control of smart municipal systems," *Latvian Journal of Physics and Technical Sciences*, vol. 54, no. 3, pp. 13–22, 2017.
- [2] H. Zhu, X. Li, and X. Lin, "Infrastructure smart service system (iS3) and its application," *Tumu Gongcheng Xuebao/China Civil Engineering Journal*, vol. 51, no. 1, pp. 1–12, 2018.
- [3] M. Grisot and P. Vassilakopoulou, "Re-infrastructure for eHealth: dealing with turns in infrastructure development," *Computer Supported Cooperative Work*, vol. 26, no. 1–2, pp. 7–31, 2017.
- [4] I. A. Rana, S. S. Bhatti, and S. e Saqib, "The spatial and temporal dynamics of infrastructure development disparity - from assessment to analyses," *Cities*, vol. 63, pp. 20–32, 2017.
- [5] G. Wang and Y. Chen, "Construction of the legal framework of Chinese-funded enterprises' agricultural investment under big data technology," *Acta Agriculturae Scandinavica Section B Soil and Plant Science*, vol. 71, no. 9, pp. 749–761, 2021.
- [6] X. Jia, "Research on the role of big data technology in the reform of English teaching in universities," *Wireless Communications and Mobile Computing*, vol. 2021, no. 1, 13 pages, Article ID 9510216, 2021.
- [7] Y. Zhang, M. Qiu, C. W. Tsai, A. Alamri, and A. Hassan, "Health-CPS: healthcare cyber-physical system Assisted by cloud and big data," *IEEE Systems Journal*, vol. 11, no. 1, pp. 88–95, 2017.
- [8] L. Xu, C. Jiang, J. Wang, Y. Jian, and R. Yong, "Information security in big data: privacy and data mining," *IEEE Access*, vol. 2, no. 2, pp. 1149–1176, 2014.
- [9] C. Yang, Y. Weng, B. Huang, and M. Ikbal, "Development and optimization of CAD system based on big data technology," *Computer-Aided Design and Applications*, vol. 19, no. S2, pp. 112–123, 2021.
- [10] L. E. Alvarez-Dionisi, "Envisioning skills for adopting, managing, and implementing big data technology in the 21st century," *International Journal of Information Technology and Computer Science*, vol. 9, no. 1, pp. 18–25, 2017.
- [11] M. Narayanan, R. G. Kumar, and J. Jayasundaram, "Big data analytics and an intelligent aviation information management system," *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, vol. 12, no. 11, pp. 4328–4340, 2021.
- [12] S. H. Majumder, N. Deka, B. Mondal, and J. Bisen, "Does rural infrastructure development affect agricultural productivity?: evidence from Assam, India," *Agricultural Research Journal*, vol. 58, no. 1, pp. 125–129, 2021.
- [13] D. Zhou, R. Wang, M. Tyrer, H. Wong, and C. Cheeseman, "Sustainable infrastructure development through use of calcined excavated waste clay as a supplementary cementitious material," *Journal of Cleaner Production*, vol. 168, no. 1, pp. 1180–1192, 2017.

Retraction

Retracted: Construction and Management of Intelligent Campus Based on Student Privacy Protection under the Background of Artificial Intelligence and Internet of Things

Mobile Information Systems

Received 26 September 2023; Accepted 26 September 2023; Published 27 September 2023

Copyright © 2023 Mobile Information Systems. 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] P. Yi and Z. Li, "Construction and Management of Intelligent Campus Based on Student Privacy Protection under the Background of Artificial Intelligence and Internet of Things," *Mobile Information Systems*, vol. 2022, Article ID 2154577, 6 pages, 2022.

Research Article

Construction and Management of Intelligent Campus Based on Student Privacy Protection under the Background of Artificial Intelligence and Internet of Things

Pujin Yi ^{1,2} and Zhongwu Li²

¹Guangxi Economic and Trade Vocational Institute, Nanning 530021, China

²National Institute of Development Administration, Bangkok 10700, Thailand

Correspondence should be addressed to Pujin Yi; yi_pujin@outlook.com

Received 12 May 2022; Revised 20 June 2022; Accepted 21 June 2022; Published 20 July 2022

Academic Editor: Amit Gupta

Copyright © 2022 Pujin Yi and Zhongwu Li. 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 coming of the era of artificial intelligence development and the mobile Internet of things, privacy security will become more and more prominent. As the contemporary college students have gradually developed into one of the main forces of the next generation of network information technology and intelligent terminals of Internet mobile communication, the problem of privacy and protection of college students in the era of artificial intelligence and the Internet of Things has naturally become a practical problem urgently solved by colleges and universities. This paper studies the application of “artificial intelligence + Internet of Things” (AIoT) in the construction and management of intelligent campus for student privacy protection. Firstly, some basic concepts and theories related to artificial intelligence and the Internet of Things are summarized, and the basic technical framework of “Artificial intelligence + Internet of Things” (AIoT) is preliminarily explained and analyzed. Secondly, relevant simulation experiments are carried out, and data support and help are provided for subsequent solutions and management methods by analyzing the simulation results. Through the investigation and analysis of the intelligent campus construction and management based on student privacy protection under the background of artificial intelligence and the Internet of Things, the final research results show that the background of artificial intelligence and the Internet of Things has a great role in promoting the function of student privacy protection, so this research has an important guiding role for student privacy protection in the context of artificial intelligence and the Internet of Things.

1. Introduction

With the development of artificial intelligence and the Internet of Things, the use of network technology will become more popular and convenient and there will be more and more users. As a new data technology, the Internet is rapidly infiltrating into various economic fields closely related to people's social life, and it is also closely integrated with the work and daily life of ordinary college students [1, 2]. In the Internet era, the rapid development of the Internet of Things has attracted worldwide attention. Many relevant institutions have made major breakthroughs in the field of IoT, such as IBM's “Smart Earth” strategy, the European Commission's “European Internet of Things Action Plan” [3, 4],

and so on. The Internet of Things is highly heterogeneous, and various networks and end entities differ greatly in processing and storage capabilities. To a certain extent, as one of the key technologies that has been widely used, the security of the Internet of Things has also been extensively studied [5, 6]. However, through in-depth research on the Internet of Things, many scholars found that there are still some security problems in the current Internet of Things system [7, 8]. The leak door of the network giant Facebook also shows that almost everyone can have no privacy in the network environment [9–12].

At present, the protection of user privacy in the Internet environment has been highly valued by governments and people around the world. In order to slow down and prevent

the occurrence of user privacy infringement, governments around the world have issued various laws, regulations, and corresponding policies. For example, the General Data Protection Regulation issued by the European Union on May 25, 2018, is considered to be the strictest and most comprehensive regulation to protect the privacy data of Internet users so far. However, even so, the security of user privacy data cannot be fully guaranteed. On the one hand, the definition of user privacy data in different application scenarios is not uniform, and the definition of privacy leakage behavior is flexible. On the other hand, attackers who violate user privacy data are usually service providers themselves or other relevant individual users, which makes it difficult for attackers to identify. Since the founding of the People's Republic of China in 1987, China has been making continuous efforts to establish and improve legal protection policies for various rights, including actively building a judicial protection system for individual privacy [13–16]. However, the legal protection of minors' privacy rights is still in the initial stage of development. Although the Internet of Things has been proved not to be a new technology a few years ago, special mandatory legislative protection is still slightly behind [3, 5, 7, 17, 18]. Through independent research, development, and operation, they have formed the application system of a personal network social platform. Most users need the third party to take the initiative to transfer part of their personal privacy and even take the initiative to grant some background data to the third party. At the same time, the artificial intelligence software and Internet products are behind another batch of the black industry chain, the company is the use of some of these industry legal blank, technical vulnerabilities, easily to the users' personal data resources, as the tool of making profit is a part of colleges and universities began trying to explore based on artificial intelligence methods and mobile Internet platform, innovate the original or traditional backward operation mode of college education innovation management in our school, and improve the management ability of big data innovation education service [19–23]. But it is in view of the current due to the domestic large-scale artificial intelligence network applications and world university biological information network technology high speed development and brings some disadvantages reality problem also let people neglected, huge amounts of reading Chinese college students' identity information, student information, and scientific research are also facing a lot of personal information leakage risk at any time. A famous domestic science and technology university due to the serious design vulnerability of its campus security application system platform and nearly led to the nation more than 70 ten thousand on college students' records all the important data privacy is leaked, the public and some domestic and foreign well-known university illegal release Chinese students personal physical health assessment report information and then extended to some foreign more top university of science and technology of China high difference transcripts, because a university management negligence leading to release. In terms of student privacy, the Internet and social big data can cause more serious privacy problems for students, forcing

major universities around the world to pay more attention to the privacy protection of college students in the era of artificial intelligence learning and the Internet of Things [24–28]. In recent years, as teachers and students of colleges and universities at all levels, as well as relevant discipline inspection and supervision departments around the province, reflect that privacy violations of college students are increasingly frequent, in order to strictly protect the privacy of college students, the website of the Ministry of Education of the People's Daily online has repeatedly issued a spot-check of the provincial law enforcement department staff and the school's network public opinion [29–31]. Verify the situation according to this spot check. In the process of privacy education management practice, colleges and universities must learn to time change the traditional concept of college students' privacy security education, make reasonable use of modern artificial intelligence knowledge, modern Internet of things tools, and social networks, and attach importance to the education protection of college students' personal privacy [32–34].

In this era of artificial intelligence society and the big Internet of Things, it is an extremely important task for our society to realize the advantages and avoid disadvantages, and to further protect the privacy information of Chinese college students while actively making good use of artificial intelligence technology and big Internet of things resources [35–38]. With modern artificial intelligence and iot research at home and abroad for academic background, and on the relevant expositions of college students' privacy protection is not much more special, so this question as far as possible in today's era background fit closely, hope it can continue to articles in the related fields of the current network security research in colleges and universities have the effect of icing on the cake.

2. Overview of Relevant Algorithms

2.1. Artificial Intelligence. Artificial Intelligence (Artificial Intelligence), abbreviated as AI, is a new technical science that researches and develops theories, methods, technologies, and application systems for simulating, extending, and expanding human Intelligence. From now, artificial intelligence discipline in many universities in the computer professional fine points out a professional artificial intelligence, he is the foundation of computer science, it is the core of the research is to explore a new kind of similar to human intelligence scientific method, designs the corresponding algorithm, research and development have similar to human thinking ability and the ability to respond to intelligent machines.

2.2. The Internet of Things. The application scenarios and application fields of the new technology integrating the Internet of Things and information technology extend from all walks of life to all aspects of people's work and life, making the limited information product resources of our industries, It will realize more efficient, optimized, reasonable use management and fair distribution, so as to greatly

improve labor productivity and promote the development of the efficiency and benefits of each major transportation industry. IoT technology and application has made good progress in solving the problem of student privacy protection in China. With the deepening of the Internet application in modern society, the problem of student privacy leakage will become a practical problem facing our country. The Internet of Things is a technology that directly transmits sensor signals to the cloud or other related devices through the network, realizing information communication and remote control between devices under a certain protocol.

2.3. Student Privacy Data Theft. One of the biggest problems for eavesdropping attacks is interference elimination. To solve this problem, under the assumption that the channel state information is transmitted in plain text, the eavesdropping attack should be based on the acquisition of the victim's channel state information. The relevant formulas for privacy data protection is

$$\begin{aligned} \begin{Bmatrix} \delta_1 \\ \delta_2 \end{Bmatrix} &= \begin{Bmatrix} \mu_1 \\ \mu_2 \end{Bmatrix} \begin{Bmatrix} \gamma_1 \\ \gamma_2 \end{Bmatrix} \begin{Bmatrix} \sqrt{\alpha_1} \varphi_1 \\ \sqrt{\alpha_2} \varphi_2 \end{Bmatrix}, \\ \varphi_1^{MS_2} &= \varphi_1 + \frac{\mu_{11}\theta_{22} - \theta_{21}\mu_{12}}{\sqrt{\alpha_1}(\mu_{21}\theta_{22} - \mu_{22}\theta_{21})}. \end{aligned} \quad (1)$$

2.4. The Impact of AI and IoT Applications on Student Privacy Protection. To strengthen the privacy protection of students in the application of artificial intelligence, it is necessary to strengthen the risk analysis and prevention of artificial intelligence applications and integrate technologies such as innovation, ethics, and the legal degree to prevent "crazy growth" and ensure that the healthy development of artificial intelligence complies with morality. In terms of technology, the development and application of security and privacy technology should be accelerated, and the privacy protection needs of students should be incorporated into the design of artificial intelligence systems to maximize privacy protection. The ethical side requires research on the principles of student privacy protection. At the same time, experts must establish socialist core values, strengthen their own norms, standardize technology application standards, processes, and methods and respect and protect students' privacy. On the legal side, we must speed up legal development and strengthen privacy protection. China's privacy protector has not yet fully adapted to the needs of artificial intelligence development. Strengthen privacy protection in relevant laws and regulations, establish legal norms when conditions are ripe, protect the privacy of the public in artificial intelligence, protect citizens' rights and choices in artificial intelligence applications, and collect and memorize personal information in artificial intelligence applications. The handling and use must be strictly regulated. This program will be used for theft, forgery, exodus, and other illegal collection and use of student materials.

TABLE 1: Frequency of publishing privacy (multiple choice questions) ($N = 500$).

| Category | Every day | Often | Once in a while | It depends | Never |
|------------|-----------|-------|-----------------|------------|-------|
| Frequency | 18 | 27 | 156 | 188 | 111 |
| Percentage | 3.6% | 5.4% | 31.2% | 37.6% | 22.2% |

TABLE 2: Do you set the visible range of privacy (multiple choice questions) ($N = 500$).

| Category | Shield strangers | Will not set | It depends | It does not matter |
|------------|------------------|--------------|------------|--------------------|
| Frequency | 251 | 68 | 159 | 22 |
| Percentage | 50.2% | 13.6% | 31.8% | 4.4% |

3. Experiments

Privacy protection includes the following aspects: data concerns: data concerns are individuals' concerns that their data will be illegally collected and used by others. Before visiting a specific platform, individuals can decide whether to continue to visit by understanding the privacy policy, laws, and regulations. Data collection risk: when an individual visits the platform online, various "traces" left on the web page will be recorded by the website or browser; that is, when individuals visit the website, they will face the possibility of data collection. College students' understanding of these contents is called data collection risk knowledge. Data supervision and protection: data supervision and protection is mainly at the level of laws and policies to regulate the processing of personal data, including the legal scope of data use, the reasonable time for data retention, and the pre-conditions for data sharing and transfer. College students' understanding of these laws and policies is called data supervision and protection knowledge. Seeking Rewards: individuals are willing to trade their data for more convenient services. For example, in order to access more content on the platform, register an account by filling in basic personal information. Social control: when individuals encounter their own data being collected, try to reduce the disclosure of more data, for example, using the wrong information or information that is not commonly used when registering. Social control primarily emphasizes personal control over the use of other platforms. Technical control: individuals use computers or certain management software to clear their personal data as much as possible to avoid misuse and misuse of data by others, resulting in serious data privacy disclosure problems. Technical control refers to a way in which individuals clear their own data. This paper uses a questionnaire to understand the current situation of college students' privacy protection in the context of artificial intelligence and the Internet of Things.

4. Experimental Analysis

4.1. Student Privacy Disclosure Degree. It can be seen from Tables 1 and 2 that college students' privacy is often ignored by colleges and universities, which can easily lead

TABLE 3: The degree of privacy concern.

| Category | name (%) | Date of birth (%) | Id number (%) | Education (%) | Health status (%) | Personal photos (%) | Home address (%) |
|------------------|----------|-------------------|---------------|---------------|-------------------|---------------------|------------------|
| Very worried | 6.5 | 8.2 | 53.1 | 5.1 | 20.3 | 33.1 | 63.7 |
| Worried | 7.7 | 9.5 | 28.7 | 6.9 | 21.7 | 30.9 | 22.1 |
| General concern | 32.0 | 35.1 | 13.2 | 27.4 | 34.3 | 21.8 | 11.8 |
| Not too worried. | 29.1 | 30.2 | 5.3 | 27.5 | 17.9 | 9.6 | 3.9 |
| Do not worry | 25.0 | 15.2 | 3.2 | 30.1 | 7.7 | 4.0 | 0.5 |

to college students' mental health problems. College students will establish their own identity files on the Internet during their usual learning process, and these files are not well protected. Colleges and universities should pay attention to this situation, and try not to disclose the private information of college students in their usual work unless they have the consent of the students themselves. College students themselves should also pay attention to privacy protection, do not easily disclose their privacy on the Internet, and have self-awareness of privacy protection.

4.2. Degree of Privacy Concern. The following is the assessment of the degree of concern about the disclosure of specific privacy content, as detailed in Table 3.

It can be seen from Table 3 that college students are more concerned about their own privacy disclosure, such as financial status and family situation. The private information of college students is often associated with the dignity of the college students themselves, which will aggravate the anxiety of college students.

4.3. Relevant Policies for Student Privacy Protection

4.3.1. Establishing the Awareness of Protecting Students' Privacy Rights. In the past few years when the Internet has flourished, it is not uncommon for students to violate the privacy rights of students. Therefore, it is necessary to fundamentally promote the protection of students' privacy rights. In practice, students' privacy rights are violated in the name of "responsibility for the benefit of students," and students' privacy rights are bound to be violated by using the materials obtained from student privacy review as the basis and means of student management. In this case, from the perspective of teachers, preventing students from playing games, and chatting online during the learning process affects their grades. Judging from the source of teacher authorization, parental authorization is obtained in the form of online parent-teacher conferences. Although the guidelines seem reasonable to protect students' right to education, it cannot be used as a reason for violating students' privacy rights. Teachers conduct activities in this way. It is also the cause of public criticism. Teachers have insufficient awareness of protecting students' privacy and lack of awareness of protecting privacy. Therefore, teachers should strengthen their awareness of protecting students' privacy in order to fully protect students' privacy.

4.3.2. Improving the School's System for Protecting Students' Privacy. Schools must fulfill the legal responsibility to protect students' privacy and improve the privacy protection system. Due to administrative needs, the school collects information on students' families. During the management process, travel information of family members can also be collected. In this case, it can be avoided if the school has a system in place to protect the privacy of students and teachers who are learning and following the rules. Therefore, it is necessary to improve the school education system and publicity and raise awareness of the privacy protection system. In practice, schools can abide by relevant laws and regulations enacted in China concerning the protection of student privacy. For example, the Law on the Protection of Minors has made some provisions to protect the privacy rights of minors and requires the principle of respecting the best interests of minors and protecting their personal data. In addition, the "Student Protection Regulations" have clear requirements for the protection of students' privacy in school education, schools shall not disclose the identity of students and their family information for the purpose of encouraging, funding and applying for poverty alleviation; schools shall, in accordance with these laws and regulations and in light of the actual situation, a school curriculum that explicitly protects student privacy in relevant laws and regulations.

4.3.3. Taking Responsibility for Violating Students' Privacy Rights. Student privacy is protected by the Constitution. If a student's right to privacy is violated at the school, the school or related personnel are responsible for violating that right. The Civil Code provides for civil liability, which can require the infringer to stop the infringement, eliminate the risk, and apologize and compensate in the event of a violation of student privacy rights and serious infringement. In addition, students or parents should not arbitrarily expand the scope of the Privacy Ordinance and deprive the school of the opportunity to conduct reasonable and necessary management.

5. Conclusions

In the era of "artificial intelligence and the Internet," the computer field is booming, and the mobile Internet, as a combination of wireless communication and computer networks, provides people with flexible and fast Internet access services. Many of the works introduced in this paper are carried out in the context of the Internet and artificial intelligence. On the other hand, when the mobile Internet

faces the challenges of emerging technologies such as big data and deep data mining, the privacy data of users is also particularly vulnerable. This paper conducts relevant investigations on the construction and management of smart campuses. The results of this paper show that the background of artificial intelligence and the Internet of Things has a great role in promoting the privacy protection function of students. Therefore, in the Internet era, in terms of personal privacy protection, artificial intelligence and Internet of Things technologies should be fully utilized to improve the degree of personal privacy protection. At the same time, because this paper only conducts experimental analysis on student groups and some aspects of privacy protection, the research on privacy protection is one-sided, and the research has shortcomings. In future research, the author will conduct research on privacy protection from different groups and levels to improve the deficiencies.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Acknowledgments

This study was supported by Research on the Influence Mechanism of Higher Vocational Teachers' Teaching Efficacy Based on Self-Evaluation (2022ZJY376).

References

- [1] R. V. Dushkin and A. I. Mohov, "Distributed computing model for the organization of a software environment that provides management of intelligent building automation systems," *Computer Research and Modeling*, vol. 13, no. 3, pp. 557–570, 2021.
- [2] R. N. Safiullin, A. S. Afanasyev, and V. V. Reznichenko, "The concept of development of monitoring systems and management of intelligent technical complexes," *Journal of Mining Institute*, vol. 237, no. 3, pp. 322–330, 2019.
- [3] D. Tien Bui, T. A. Tuan, N. D. Hoang et al., "Spatial prediction of rainfall-induced landslides for the Lao Cai area (Vietnam) using a hybrid intelligent approach of least squares support vector machines inference model and artificial bee colony optimization," *Landslides*, vol. 14, no. 2, pp. 447–458, 2017.
- [4] P. Qian and M. Wu, "Overview of privacy protection research and methods in the Internet of things," *Computer application research*, vol. 30, no. 1, p. 8, 2013.
- [5] Z. Lv and S. Lv, "Clinical characteristics and analysis of risk factors for disease progression of COVID-19: a retrospective Cohort Study," *International Journal of Biological Sciences*, vol. 17, pp. 1–7, 2021.
- [6] X. L. Dong, "Research Progress on privacy protection of Internet of things," *Computer research and development*, vol. 52, no. 10, pp. 2341–2352, 2015.
- [7] D. Yu, Z. Ma, and R. Wang, "Efficient smart grid load balancing via fog and cloud computing," *Mathematical Problems in Engineering*, vol. 2022, Article ID 3151249, 11 pages, 2022.
- [8] C. L. Li, "Introduction to privacy protection mechanism of Internet of things," *Fujian computer*, vol. 27, no. 4, p. 2, 2011.
- [9] T. Naumovic, L. Baljak, L. Živojinović, and F. Filipovic, "Development of a software framework for real-time management of intelligent devices," *Proceedings of the Institute for System Programming of the RAS*, vol. 31, no. 3, pp. 35–46, 2019.
- [10] M. Topolski, "Management of intelligent internal transport through computer-based probabilistic algorithms," *AUTOBUSY – Technika Eksploatacja Systemy Transportowe*, vol. 19, no. 6, pp. 968–972, 2018.
- [11] Q. Sun, K. Lin, C. Si, Y. Xu, S. Li, and P. Gope, "A secure and anonymous communicate scheme over the Internet of things," *ACM Transactions on Sensor Networks*, vol. 18, no. 3, pp. 1–21, 2022.
- [12] H. Cheng, M. Shojafar, M. Alazab, R. Tafazolli, and Y. Liu, "PPVF: privacy-preserving protocol for vehicle feedback in cloud-assisted VANET," *IEEE Transactions on Intelligent Transportation Systems*, pp. 1–13, 2021.
- [13] V. A. Tabakaeva, I. N. Karmanov, and V. R. An, "Features of intelligent information security management systems for critical information infrastructure objects," *Interexpo GEO-Siberia*, vol. 6, no. 2, pp. 99–104, 2020.
- [14] O. Katerna, "Concept formulation of intelligent management in transport," *Modern Economics*, vol. 9, no. 1, pp. 30–42, 2018.
- [15] J. Chen, Y. Liu, Y. Xiang, and K. Sood, "RPPTD: robust privacy-preserving truth discovery scheme," *IEEE Systems Journal*, pp. 1–8, 2021.
- [16] P. Wang and Y. Liu, "SEMA: secure and efficient message authentication protocol for VANETs," *IEEE Systems Journal*, vol. 15, no. 1, pp. 846–855, 2021.
- [17] Ł. Marzantowicz, "Changes in contemporary logistics management in the light of intelligent logistics," *Kwartalnik Nauk o Przedsiębiorstwie*, vol. 50, no. 1, pp. 62–71, 2019.
- [18] D. Yu, J. Wu, W. Wang, and B. Gu, "Optimal performance of hybrid energy system in the presence of electrical and heat storage systems under uncertainties using stochastic p-robust optimization technique," *Sustainable Cities and Society*, vol. 83, Article ID 103935, 2022.
- [19] M. Shakeri, M. Shayestegan, H. Abunima et al., "An intelligent system architecture in home energy management systems (HEMS) for efficient demand response in smart grid," *Energy and Buildings*, vol. 138, pp. 154–164, 2017.
- [20] A. Lei, H. Cruickshank, Y. Cao, P. Asuquo, C. P. A. Ogah, and Z. Sun, "Blockchain-Based dynamic key management for heterogeneous intelligent transportation systems," *IEEE Internet of Things Journal*, vol. 4, no. 6, pp. 1832–1843, 2017.
- [21] W. Zheng, L. Yin, X. Chen, Z. Ma, S. Liu, and B. Yang, "Knowledge base graph embedding module design for Visual question answering model," *Pattern Recognition*, vol. 120, Article ID 108153, 2021.
- [22] W. Zheng, X. Liu, X. Ni, L. Yin, and B. Yang, "Improving visual reasoning through semantic representation," *IEEE Access*, vol. 9, pp. 91476–91486, 2021.
- [23] W. Zheng, X. Liu, and L. Yin, "Sentence representation method based on multi-layer semantic network," *Applied Sciences*, vol. 11, no. 3, p. 1316, 2021.
- [24] K. Mistry, L. Zhang, S. C. Neoh, C. P. Lim, and B. Fielding, "A Micro-GA Embedded PSO feature selection approach to

Retraction

Retracted: Coordinated Development of China's Regional Economy and Ethnic Diversity under the Background of Big Data and the Internet of Things

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Miao, "Coordinated Development of China's Regional Economy and Ethnic Diversity under the Background of Big Data and the Internet of Things," *Mobile Information Systems*, vol. 2022, Article ID 6424505, 8 pages, 2022.

Research Article

Coordinated Development of China's Regional Economy and Ethnic Diversity under the Background of Big Data and the Internet of Things

Hongliang Miao ^{1,2}

¹*School of Economics and Management, Hulunbuir University, Hulunbuir 021008, China*

²*Tehua Postdoctoral Programme, Beijing 100000, China*

Correspondence should be addressed to Hongliang Miao; miao_hongliang@outlook.com

Received 10 May 2022; Revised 16 June 2022; Accepted 22 June 2022; Published 20 July 2022

Academic Editor: Amit Gupta

Copyright © 2022 Hongliang Miao. 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 the context of big data and the Internet of Things, the development of the Chinese nation is changing with each passing day, and the regional economic development has also shown a long-handed trend. With the development of the diversity of the Chinese nation, it has become more and more prosperous, which drives the sustainable development of the regional economy, but in the process of regional economic development, it also reflects the various contradictions and problems of my country's economy in the ethnic minority regional economy. By studying the current status of Chinese nation diversity and regional economic development under the background of big data and the Internet of Things, this article pointed out the problems and contradictions in the development of national diversity and regional economic development, through the use of thermodynamic computing models for data analysis, and based the status quo of the economic development of Xinjiang region is an example, and it proposes measures to promote the coordinated development of the Chinese nation's diversity and regional economic coordinated development.

1. Introduction

The development of big data and the Internet of Things technology, with the prosperity of information technology, shows the relationship between overlapping and dependence on each other. The Internet of Things focuses on the Internet of the Internet and forms an interconnection of all things under information technology [1–3]. The big data is to collect and process the large amount of data in the entire research carrier and form a multidimensional and multifaceted analysis processing method. In the context of the Internet of Things and big data, studying the current status of Chinese nation diversity and regional economic coordinated development is a one new angle [4–6].

With the development of information network technology, the economic development of China's ethnic minorities depends on the continuous integration and development of the ethnic regional economy and ethnic economy [7–10]. Today, with the gradual prosperity of the

ethnic regional economy, the national economy has shown the contradiction and problems of imbalanced development under the drive of its regional development [11–13]. It is mainly reflected in the huge differences between urban and rural gaps, regional gaps, and the huge differences between the first, second, and third industries. This article studies the current status of economic development in Xinjiang's ethnic region, studies its overall development status of the regional economy in 2021, and provides reference for the economic development of the ethnic regional and national diversity [14, 15]. As the economic differences of the ethnic regional region gradually widen, the factors of social instability have gradually become highlighted, and the security, stability, and division of splitting forces in Xinjiang have also been sighed, affecting the economic construction and development of the ethnic region. This paper studies the current status of the economic development of the ethnic region through examples and put forward measures with practical guidance.

2. The Current Status of Chinese Nation Diversity and Regional Economic Development

2.1. Status of the Development of National Diversity. China has more than 5,000 years of brilliant civilization. During the historical development process of 5000 years, the nation has continuously integrated, prosperous, and developed, showing the characteristics of versatile and difference [16–19]. With the continuous advancement of national integration, the Han nationality became the most important nation in China, and it also covered 55 ethnic minorities [20–23]. From a historical perspective, the development of the Chinese nation is analyzed. The ancient Chinese civilization is like African civilization, European civilization, American civilization, and ocean continents, the main body of the entire world and all human civilization [24, 25]. Since the 21st century, the Han nationality accounts for 91.51% of the total population of the country, while the remaining 55 ethnic minorities have a total population of 8.49% (Figure 1).

As one of the countries and regions with a wide range of ethnic groups in the world, China has developed to 56 increasingly prosperous ethnic groups today with the continuous reproduction and renewal of Chinese ethnic groups in the process of historical changes, with the migration of regional nations and natural disasters of war [26, 27]. The distribution of ethnic minorities is relatively concentrated, forming their respective language and cultural characteristics. There are both homologous relationships and different differences between ethnic groups [28–30]. According to ethnic language, 56 ethnic groups in China have found more than 130 different languages. They belong to the 10 language of five prodigal systems. Among them, Chinese and Tibetan language are the most abundant.

The continuous prosperity and development of national diversity has given the people of all ethnic groups in the country to cherish and maintain the ideological root of their nation's civilization. The cultural root of the nation has established a national culture of self-esteem, self-confidence, self-reliance, and self-reliance [31]. While all ethnic groups focus on maintaining and showing their own characteristics and typical culture, they have also formed a more integrated and inclusive national development trend in the exchange and integration. As the domestic economic construction and development are becoming more and more prosperous between ethnic cultural exchanges and ethnic areas [32], the national exchanges are getting deeper and deeper, and the peaceful, development, justice, democracy, and freedom of national exchanges has been established, so that the integration and development of all ethnic groups will be more open and tolerant and diverse. It has formed a fair and harmonious development environment in the development of 56 ethnic groups in China's ethnic diversity. While protecting the diversity of the nation, the Chinese government has also introduced corresponding policies and regulations to promote the development of national diversity, promote the integration of multi-ethnic groups, and achieve steady development of regional economy.

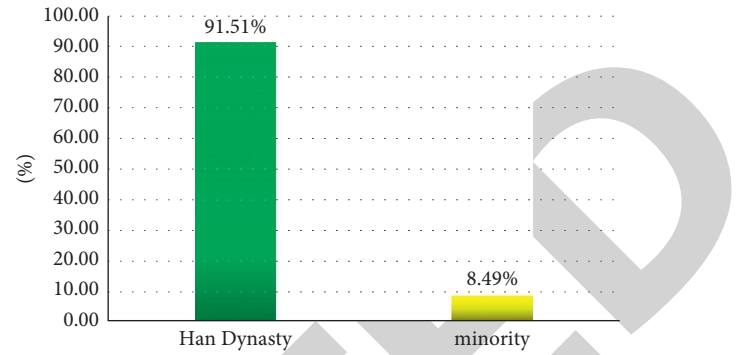


FIGURE 1: The proportion of Han and ethnic minorities in the Chinese nation.

2.2. Regional Economic Development Status Quo. The development of the ethnic regional economy has different economic subjects formed in different regions, such as the Mongolian economy and the Uyghur economy. In the process of the economic development of the ethnic region, different national economies have formed their respective economic characteristics. Through the integration and development of the ethnic regional economy, it has allowed in different regions, such as Tibet, Xinjiang and other regions. A regional economic development trend with its unique national characteristics has been formed. The main body of the regional economy in the pastoral area of the Tibetan area reflects the distinctive characteristics of the Tibetan economy and other regional economies. In the process of establishing and forming their own national economic development characteristics, all ethnic groups have economic development characteristics that gradually formed with the course of national culture and national development. At present, China has given a lot of financial and policy support in the process of supporting the economic development of the ethnic region. The huge financial support of the central government has promoted the continuous integration and balance of regional economic development. Obviously, the current status of the traditional agricultural and animal husbandry in some ethnic economic development is still very obvious. The development of the first industry's development accounted for the main proportion of the overall ethnic regional economy reflects the problems and deficiencies of the ethnic regional economy in development.

With the economic development of the ethnic region and the unique economic forms between the ethnic groups, the economy of various ethnic groups also shows a prosperity. During the development of the regional economies of various ethnic groups, in the process of development, it depends on its economic development foundation, created regional economic characteristics, formed a geographical advantage of the development of the ethnic economy, and led to the national regional economy Overall development will analyze the prosperity of the national regional economy at the theoretical level, basically integrates the economic development advantages between nations. With the support and encouragement of national policies, the economic exchanges between all ethnic groups are more diverse and

TABLE 1: The R&D institutions of large- and medium-sized high-tech industries in eight provinces and regions of the ethnic group accounted for the proportion of the country in 2021 (unit: one, 10,000 yuan,%).

| Area | Large enterprise | | | | Medium -sized enterprise | | | |
|----------------|------------------------------------|--------|-----------|-------------|------------------------------------|--------|-----------|-------------|
| | Science and technology institution | Number | Personnel | Expenditure | Science and technology institution | Number | Personnel | Expenditure |
| East | 80.19 | 78.22 | 83.25 | 89.83 | 77.17 | 75.19 | 78.79 | 85.82 |
| West | 8.18 | 6.20 | 5.16 | 2.22 | 8.50 | 10.20 | 8.53 | 7.50 |
| Inner Mongolia | 1.19 | 3.26 | 3.20 | 3.11 | 0.25 | 0.20 | 1.01 | 0.21 |
| Guangxi | 0.78 | 2.80 | 0.79 | 4.07 | 0.24 | 0.10 | 0.22 | 0.02 |
| Guizhou | 1.22 | 0.22 | 0.59 | 2.01 | 0.52 | 0.21 | 0.12 | 0.08 |
| Yunnan | 0.41 | 1.39 | 1.20 | 1.01 | 0.33 | 0.12 | 0.13 | 0.03 |
| Tibet | 2.20 | 1.20 | 2.20 | 1.20 | 0.15 | 0.12 | 0.12 | 0.05 |
| Qinghai | 1.40 | 2.38 | 3.02 | 2.10 | 0.18 | 0.23 | 0.05 | 0.05 |
| Ningxia | 2.17 | 1.20 | 2.09 | 2.01 | 0.30 | 0.31 | 0.08 | 0.08 |
| Xinjiang | 4.20 | 5.18 | 1.10 | 2.02 | 0.25 | 0.21 | 0.22 | 0.10 |

Data source: China's high-tech industry statistics.

more popular. The economic development among the nations in the region is more balanced, and it has also promoted the continuous prosperity and stability of the nation's diversity.

In Table 1, we investigated the large- and medium-sized high-tech industrial R&D institutions of the eight major ethnic regions in 2021. Among them, the eastern region still occupies the main part of the proportion of high-tech industries in the entire regional economic development process. With the support of national tendencies, it has also shown a trend of gradual improvement.

3. Analysis of the Reasons for the Imbalance between National Diversity and Regional Economic Development

3.1. Regional Economy Is Separated from National Diversity and Develops Isolated. The development of the regional economy cannot be separated from the economic exchanges and integration of various nations and cannot be independent of national diversity. The economic development of the ethnic regional region is development with political tasks and the basis for the balanced development of my country's entire economy. In order to promote equal exchanges and economic prosperity between domestic nations, the state has launched corresponding policy support and funding guarantee, thereby promoting the prosperity of ethnic economy in the central and western regions. Balanced development has a huge role in promoting and guaranteeing the improvement of people's lives in the ethnic region and the improvement of people's lives in ethnic minority areas. The development of regional economy and the integration of national diversity can effectively ensure the use of the economic characteristics of the ethnic groups and realize the effective integration and long-term development of the economy between the nations in the region. In the planned economy system, the nation under the development of regional economy achieves common development through economic exchanges, so that economic progress among the nation will unify the differentiation of their nations, realize

the coordinated development of regional economy, and promote the people of ethnic minorities. The overall improvement of living standards has achieved more frequent exchanges within the region and promoted the prosperity of the entire ethnic regional economy.

3.2. Regional Economic System Preferential Treatment Continues to Improve. The development of the ethnic regional economy is an important part of the Chinese national economy. With the policy support of the central and local departments for the economic development of the ethnic region, the state has given certain benefits and help in terms of economic development and tendency policy support. The construction and approval of regional economic projects has established a set of green and fast approval processes to organically integrate the development of ethnic minorities and regional economic construction to achieve the long-term development of the ethnic regional economy. Some departments do not take national economic development as their responsibility but use the economic development of the ethnic region as the final service goal. The total economic volume of the ethnic regional economy has increased, but the economic development between nations is very uneven, and the effectiveness of the policy and system does not play well. Although the regional economy is constantly moving forward, it is very unfavorable for the economic development of some ethnic minorities.

Based on the deviation of different government departments on economic policy awareness, the role and intensity of the regional economy are different in the process of implementing policies. In recent years, a series of national and regional economic development strategies such as the western development strategy of the country, the revitalization and development strategy of the Northeast Old Industrial Base, and the rise and development strategy of the central and western regions represent the overall development status of the regional economy. It is undeniable that the regional economy has achieved new breakthroughs in total, but some ethnic economy has been suppressed and excluded during the development process and is in a

disadvantage in fierce competition. The state's support in fund policy investment has not been refined to the effective development of different ethnic economies, making the entire regional economic development insufficiently balanced.

In the process of development based on the above-mentioned uneven development, we quoted the analysis principles of entropy pollution described in the second law of thermodynamics to analyze the disadvantages of the national economic development brought about by the regional economic development process. The formula is as follows:

$$F_{ij} = \frac{S1_{ij} - S2_{ij}}{K1_{ij}}. \quad (1)$$

Through the abovementioned strict data theory analysis, the development of the ethnic regional economy has the ability to sustainable development and the establishment of a scientific evaluation index system to evaluate and judge the sustainable development capacity of the ethnic regional economy, which is conducive to the balanced ethnic economy within the region. At the same time, through the calculation of the risk index system, the problems of the regional economic discovery can be predicted, and the economic construction and social development science and social development in the ethnic region can be achieved through targeted avoidance measures.

Based on the establishment of a stable regional economic development environment, the entropy value model in the economic development environment can be set to:

$$F_j = \frac{S \cdot (W_g/W_t - 1) \cdot T}{P \cdot (K_s + K_w) \cdot H \cdot G}. \quad (2)$$

In the above formula, F represents the general business value of the regional economic system. As the ratio of GDP investment growth rate in the regional economy and the national GDP investment growth rate, W is the growth rate of the overall GDP. T is the price index of the regional economy. P represents the ratio of GDP and national GDP per capita in the regional economy. Z represents the proportion of the third industry output value in the area. KW represents the proportion of total imports in the area. H is an innovation index. G is the traffic index. In the above-mentioned entropy theory analysis, consumption ratio is as higher as of 10,000 yuan GDP, which means that the more the corresponding products and energy consumed in the region, the greater the impact on the natural environment and the regional economy. The greater the influence of the index, the greater the impact of the growth rate of fixed asset investment in the regional economy, resulting in smaller investment reports.

According to economic theory judgments, the higher the proportion of the third industry GDP in a region, the greater the economic development potential in the region and stronger the sustainable economic development capacity. The GDP of the tertiary industry in the upper formula, as an important indicator factor, occupies an important position in the calculation of the economic entropy value of the region. By continuously improving technical means, the

development potential of the tertiary industry is enhanced, and the sustainable development of the ethnic regional economy has been achieved.

3.3. Economic Development of Ethnic Regional and Imbalances in the Development of Ethnic Economic Development. The phenomenon of imbalanced ethnic economic development brought about by the economic development of the ethnic regional region has led to the limited level of economic development in some nations; the gap between the living standards of people's living standards has continued to increase, and a huge national gap in the entire regional economic development has generated a huge national gap.

Taking the economic development of the Xinjiang region as an example, the GDP in Xinjiang in 2021 was 1598.365 billion yuan from 2020. Among them, the added value of the first real estate industry was 235.606 billion yuan, an increase of 7.9% over 2020; the added value of the second industry was 596.736 billion yuan, an increase of 6.7% in 2020; the tertiary industry increased by 6.9%, the added value reached 7660.23 billion yuan. Analyzing the proportion of the total economic development of the entire first, second, and third industries in Xinjiang, the proportion of first, second, and tertiary industries accounted for 14.7%, 37.4%, and 47.9%, respectively. Due to the wide distribution of various ethnic groups within Xinjiang, the total output value of the per capita region of the year reached 61,725 yuan, an increase of 6.3% over the previous year, but the economic development gap between nations is still obvious as shown in Table 2.

From the perspective of the economic development of Xinjiang region, the southern Xinjiang region accounts for 30.1% of the total economic volume of the region, and the northern Xinjiang region accounts for 69.9% of the economic aggregate in the region. In the regional economic development of Xinjiang region, there is also a deficiency of imbalance.

The consumer price of residents of various ethnic groups in Xinjiang, increased by 1.2% compared to 2020. Among them, the ups and downs of different categories are also different, and the specific gains are as shown in Table 2. From Figure 2, we can find that traffic communication, clothing, and residential categories have increased, while there is a downward trend in education, cultural entertainment, and other products and services, reflecting the slow development of the tertiary industry in Xinjiang.

The production price of the Xinjiang region PPI has increased by 19.4% compared to 2020. From the aspects of use, final products, industry, and other aspects, the increase in specific categories is shown in Table 3. From Table 4, we can find that PPI increases in production data categories; heavy industrial products; primary products; and oil, steel, coal, and other related industries, indicating that Xinjiang still depends on the first industry. Development is still the main driving force for economic growth in the region.

Analysis of the purchase price of industrial producers in Xinjiang area shows an increase of 15.0% compared with 2020 in 2021, and we conducted a comprehensive investigation of the prices of the nine categories of raw materials as shown in Figure 3. Among them, the purchase price of fuel

TABLE 2: The development status of the first, second, and tertiary industries in Xinjiang area in 2021.

| Serial number | Industry | Value added | Growth than last year (%) | Occupy the proportion of regional total value (%) |
|---------------|-------------------------------|----------------------|---------------------------|---|
| 1 | Primary industry | 235606 billion yuan | 7.89 | 14.68 |
| 2 | Secondary industry | 596.736 billion yuan | 6.71 | 37.38 |
| 3 | Tertiary industry | 7660.23 billion yuan | 6.91 | 47.92 |
| 4 | Total value of the whole year | 1598365 billion yuan | 6.9 | |
| 5 | Per capita area total value | 61725 yuan | 6.28 | |

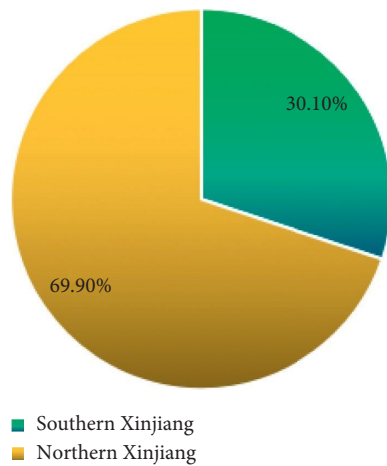


FIGURE 2: The proportion of economic development in various regions in Xinjiang.

TABLE 3: Consumption price CPI in various ethnic groups in Xinjiang area.

| Serial number | Category | Increase |
|---------------|--|----------|
| 1 | Traffic | 4.6% |
| 2 | Clothing | 2.1% |
| 3 | Residence | 1.2% |
| 4 | Food tobacco and alcohol | 0.8% |
| 5 | Daily necessities and service categories | 0.3% |
| 6 | Health care | 0.2% |
| 7 | Education, culture, and entertainment | -0.1% |
| 8 | Other supplies and service categories | -0.6% |

TABLE 4: The production and export price of Xinjiang area PPI situation in 2021.

| Number | Category | Serial number (%) |
|--------|-------------------------|-------------------|
| 1 | Production information | 20.7 |
| 2 | Living information | 4.2 |
| 3 | Light industry | 7.5 |
| 4 | Heavy industry | 21.2 |
| 5 | Primary product | 23.1 |
| 6 | Intermediate product | 18.8 |
| 7 | Final product | 12.9 |
| 8 | Oil -related industry | 25.7 |
| 9 | Steel -related industry | 30.3 |
| 10 | Coal -related industry | 30.4 |

power, metal materials, agricultural products, and fishery products has increased, reflecting the increasing cost investment in Xinjiang's first industries, and the profit of the first industry has gradually decreased, resulting in the entire

industry. The speed of regional economic development has gradually slowed down, affecting the sustainable development of the regional economy.

4. The Development Advantage Brought by the Technical Background of the Internet of Things and the Internet of Things

Big data and Internet technology have brought new advantages to regional economic development. For regional economic development supported by the national economy as the development, through the continuous integration of national diversification, government departments should pay attention to the coordination and complement of the national economy.

4.1. Elimination of the Development of the National Economy Will Lead to the Wrong Understanding of National Division.

The development of the regional economy depends on the effective coordinated development of the economies of the national economy. It is necessary to break the wrong perception of national economic development from the ideological development of the nation. With the precedent of the Russian economy and Ukraine's economic development, we can draw conclusions, and in the ethnic regional economy during the development process, we must continue to promote and coordinate the common development of the national economy. By adopting corresponding support policies and remedial measures, the coordination and advancement of the various ethnic economies within the regional economy continuously narrow the gap between the economies of the ethnic groups, break away from the internal ethnic groups. Economic closure allows economic integration and common prosperity between the ethnic groups within the region.

4.2. To Further Clarify the Economic Rights of Ethnic Minorities.

The development of the ethnic regional economy depends on the guarantee of the national economic power. Local governments at all levels must implement the national economic protection measures in ethnic autonomous regions to protect the sovereignty and interests of the ethnic economy. In addition, they should encourage the construction of major projects to promote the coordinated development of the ethnic minorities' economy. At the same time, the quality of economic development in the process of regional economic development should be focused on the orderly progress and sustainable development of the economy within the region.

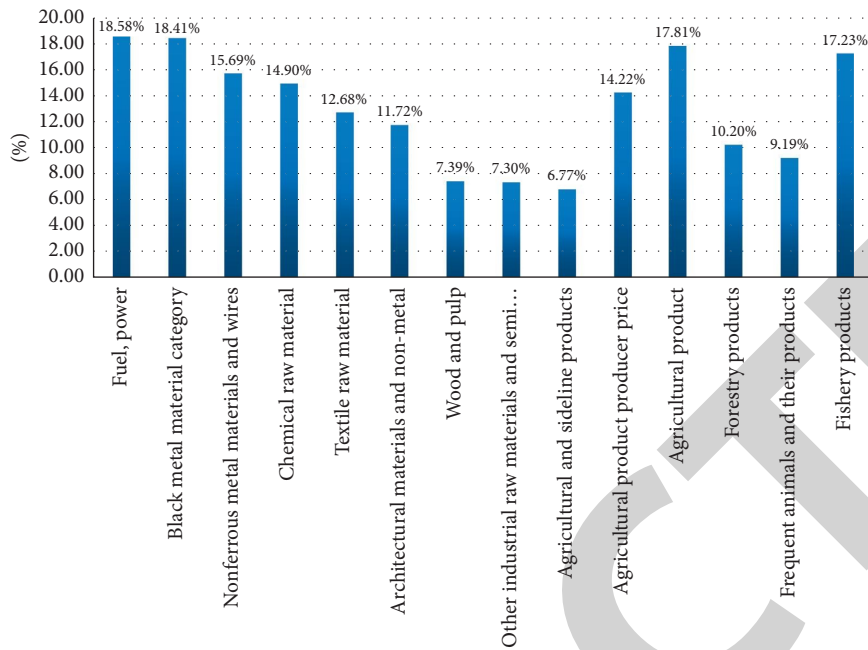


FIGURE 3: Analysis of the purchase price of industrial producers in Xinjiang in 2021.

4.3. Formulate a Special National Economic Development Plan. The economic development of the region of each ethnic group must be based on the national “Fourteenth Five-Year Plan” development plan, and formulate the general plan for the economic prosperity and development of the various ethnic groups in the region. The simple regional economic development strategy is no longer suitable for the current economic development situation at this stage. It is necessary to formulate a special national economic development strategy and continuously exchanged and cooperate with the economic development of local regions across the country, promote the continuous prosperity and development of the lagging national economy, and promote the sustainable economic growth within the regional economy. In 2021, the National Civil Affairs Commission promoted 22 ethnic minority development projects to support some key construction projects of some ethnic minorities, especially to provide strong policy support for the economic development projects of the poor ethnic group and Xingbianfu project. Through the “Belt and Road” construction, the integration and development of the ethnic regional economy and the country and the global economy has been realized.

4.4. To Increase the Quality and Skills Training of Ethnic Minorities Workers. The development of the ethnic regional economy and the current development trend of economic industrialization and urbanization are not separated. The road of new industrialization development is an important direction for the development of the economy of various ethnic groups. In the process of conducting quality and skills training for workers, we must start from the younger generation. Relevant local departments must jointly cultivate technical personnel, engineering construction personnel, financial management personnel, and economic managers

within all ethnic groups to help all ethnic groups within talent training to create good development potential, while relying on the education of various ethnic universities, and realize the exchange of ethnic and technical personnel in various language environments.

4.5. Utilizing the Achievement of National Regional Economic Achievements to Promote the Development of National Economy. The long-term progress and development of the ethnic regional economy depends on the construction of the national economy. On the one hand, in the process of national economic development, we must pay attention to the support and assistance of some people’s economy, especially in terms of labor output and tax policies. In the process of economic development of the entire ethnic region, by shortening the gap between the economies of various ethnic groups, the orderly development of the economy within the entire region, and creating a relatively fair and harmonious economic development environment. Ethnic autonomous areas should incorporate national economic development planning into the route of regional economic development planning, allowing the development of the national economy to promote the long-term sustainable development of the regional economy, integrate the traditional ethnic economic industry and regional economic development, and realize the traditional industries and emerging coordinated development of the industry.

5. Conclusion

This article has studied the status quo of the development of national diversification, the promotion and integration of the economic development of the ethnic economy and the economic development of the ethnic region, and the regional

economic development study after the thermodynamics analysis model, Ethnic economic development has an important impact on regional economy. The development of the ethnic regional economy and the national economy is unified. In the process of decades of national economic development, the problems reflected in the economic development of Xinjiang region are also the contradictions in the economic development of the region of various ethnic groups. By excavating the internal economic resources of various ethnic groups, let ethnic minorities participate in economic construction and share the achievements of economic construction results and get out of the road of ethnic diversification, ethnic regional economy, and the coordinated and sustainable development of the economy.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

It is declared by the authors that they have no conflicts of interest.

References

- [1] L. B. Yang, "Analysis of Economic Growth and its Dynamic Cause of China's Nation Region," *Economic system reform*, pp. 125–128, 2012.
- [2] X. T. Fei, *A Diverse and Integrated Pattern of the Chinese Nation*, Minzu University Press, Beijing, China, 1999.
- [3] R. Ma, *The History and Status Quo of Chinese National Issues*, Journal of Yunnan National University, Yunnan, China.
- [4] B. Wang and Y. Yuan, "And the research on the development of characteristic economic development in the ethnic area of Chongqing — take the economic development under the forest of the Yunyang Qingshu and Earth Family Forest of Yunyang, Chongqing as an example," *Commercial economy*, vol. 19, pp. 70–71, 2010.
- [5] X. T. Lei, Q. Y. Xu, and C. Z. Jin, "Nature of property right and the motives for holding cash: empirical evidence from Chinese listed companies," *Managerial and Decision Economics*, vol. 43, no. 5, pp. 1482–1500, 2021.
- [6] Y. Wu and W. Zhu, "The role of CSR engagement in customer-company identification and behavioral intention during the COVID-19 pandemic," *Frontiers in Psychology*, vol. 12, Article ID 721410, 2021.
- [7] T. Wang, B. Xiang, Y. Wang et al., "Spectroscopic investigation on the binding of bioactive pyridazinone derivative to human serum albumin and molecular modeling," *Colloids and Surfaces B: Biointerfaces*, vol. 65, no. 1, pp. 113–119, 2008.
- [8] Z. Wang, R. Ramamoorthy, X. Xi, K. Rajagopal, P. Zhang, and S. Jafari, "The effects of extreme multistability on the collective dynamics of coupled memristive neurons," *The European Physical Journal - Special Topics*, 2022.
- [9] Z. Wang, R. Ramamoorthy, X. Ramamoorthy, H. Xi, and H. Namazi, "Synchronization of the neurons coupled with sequential developing electrical and chemical synapses," *Mathematical Biosciences and Engineering*, vol. 19, no. 2, pp. 1877–1890, 2021.
- [10] W. Zheng, L. Yin, X. Chen, Z. Ma, S. Liu, and B. Yang, "Knowledge base graph embedding module design for Visual question answering model," *Pattern Recognition*, vol. 120, Article ID 108153, 2021.
- [11] Z. J. Hu, X. C. Jiang, and J. Xiao, "etc. Thinking of the county's economic development model in the ethnic area takes Guizhou as an example," *Anhui Agricultural Science*, vol. 36, no. 3, pp. 1244–1246, 2008.
- [12] L. H. Xu and Y. D. Wu, "Design of the development of characteristic economy and optimizing industrial structure policy in the Southwest Ethnic Region," *Economic issues exploration*, vol. 1, pp. 94–99, 2007.
- [13] Y. Yuan, "On the characteristics of the characteristics of the nation's nation -region," *SAR economy*, vol. 5, pp. 197–199, 2007.
- [14] Z. F. Su, "Feature economy: the point of implementing the scientific concept of development in the western ethnic region," *Economic issues exploration*, vol. 1, pp. 37–40, 2006.
- [15] B. Wang and Y. Yuan, "Research on the development of characteristic economic development in the ethnic area of Chongqing takes the economic development under the forest of the Yunyang Qingshu and Earth Family Forest in Chongqing as an example," *Commercial economy*, vol. 19, pp. 70–71, 2010.
- [16] T. Wang, B. Xiang, Y. Wang et al., "Spectroscopic investigation on the binding of bioactive pyridazinone derivative to human serum albumin and molecular modeling," *Colloids and Surfaces B: Biointerfaces*, vol. 65, no. 1, pp. 113–119, 2008.
- [17] Z. J. Hu, X. C. Jiang, and J. Xiao, "Thinking of the county's economic development model in the ethnic area takes Guizhou as an example," *Anhui Agricultural Science*, vol. 36, no. 3, pp. 1244–1246, 2008.
- [18] L. H. Xu and Y. D. Wu, "Design of the development of characteristic economy and optimizing industrial structure policy in the Southwest Ethnic Region," *Economic issues exploration*, no. 1, pp. 94–99, 2007.
- [19] Y. W. Yang and D. Z. Liu, "The Economic Development Path of Ethnic Minority Autonomous Prefectures," *Journal of Yunnan Minzu University*, Kunming, China, 2019.
- [20] W. Zheng, X. Liu, X. Ni, L. Yin, and B. Yang, "Improving visual reasoning through semantic representation," *IEEE Access*, vol. 9, Article ID 91476, 2021.
- [21] W. Zheng, X. Liu, and L. Yin, "Sentence representation method based on multi-layer semantic network," *Applied Sciences*, vol. 11, no. 3, p. 1316, 2021.
- [22] L. T. He, L. P. Mu, J. A. Jean et al., "Contributions and challenges of public health social work practice during the initial 2020 COVID-19 outbreak in China," *British Journal of Social Work*, Article ID bcac077, 2022.
- [23] L. Yao, X. Li, R. Zheng, and Y. Zhang, "The impact of air pollution perception on urban settlement intentions of young talent in China," *International Journal of Environmental Research and Public Health*, vol. 19, no. 3, p. 1080, 2022.
- [24] State council, *The "Thirteenth Five-Year Plan" of the State Council Promotes the Development Plan of Ethnic Regions and the Number of Young People in the Nation*, 2016.
- [25] C. Cheng and L. Wang, "How companies configure digital innovation attributes for business model innovation? A configurational view," *Technovation*, vol. 112, Article ID 102398, 2022.
- [26] Y. H. Wu, "Dalian big data industry development issue and countermeasure research," *Liaoning Economics*, no. 1, pp. 28–30, 2018.

Retraction

Retracted: Soccer Player Video Target Tracking Based on Deep Learning

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] B. Zheng, "Soccer Player Video Target Tracking Based on Deep Learning," *Mobile Information Systems*, vol. 2022, Article ID 8090871, 6 pages, 2022.

Research Article

Soccer Player Video Target Tracking Based on Deep Learning

Bo Zheng 

School of Physical Education, Chengdu Normal University, Chengdu 611130, Sichuan, China

Correspondence should be addressed to Bo Zheng; 731025@cdnu.edu.cn

Received 16 May 2022; Revised 13 June 2022; Accepted 16 June 2022; Published 6 July 2022

Academic Editor: Amit Gupta

Copyright © 2022 Bo Zheng. 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.

Soccer player video target tracking is a very challenging task, which has good practical and commercial value. Traditional soccer game target tracking relies on athletes to carry a recording chip to achieve target tracking, but the cost is very high. With the rapid development of photography technology and deep learning technology, athletes' target tracking is realized through soccer game video. Deep learning technology is applied to computer vision detection and tracking. How to realize soccer players' video target tracking under deep learning is a challenging lesson. To solve this problem, this paper takes the video target tracking of football players as the research object, collects the game images of the stadium through multiple cameras, realizes the long-term accurate tracking of multiple players, and establishes a multicamera multitarget tracking system. The KCF algorithm and the improved KCF algorithm formed by replacing the hog feature of the KCF algorithm with the depth convolution neural network are used to compare and analyze the impact of different target tracking ranges and target numbers on the target tracking accuracy of the system, so as to accurately obtain the motion trajectory of football players. The results show that the image data of football matches are collected independently by multiple cameras, and the data of multiple cameras are collected to generate each target motion datum. The KCF algorithm of multicamera multitarget tracking has good robustness and real-time for long-term accurate tracking of football players; the KCF algorithm and the improved KCF algorithm have high accuracy in target tracking. With the increase of tracking frame range, the accuracy of target tracking of the two algorithms is improved. At the same time, multitarget tracking helps to improve the antiocclusion ability of the system. The research results have important practical significance and good application prospects for the analysis technology of video content of football matches.

1. Introduction

With the development of the Olympic Games and the world cup, especially in the form of computer technology, the number of video clicks and the world cup are gradually improved. As the most ornamental sport, football is loved all over the world. The analysis of football game video mainly includes player tracking, player activity map, and referee video map [1]. The target detection and tracking of video is the key technology to realize these. Football videos often add various special effects to attract attention. Coaches and analysts analyze some motion data through videos. Players also want to watch their own game performance, and these behaviors need to rely on target motion trajectory extraction technology [2, 3]. For major football matches, these needs must be met one by one. Only by increasing the cost and increasing the investment of human and material resources

can they be realized. However, for some amateur football matches, low-cost target tracking schemes have more practical value and practical significance [4].

In the aspect of target tracking of football players, scholars at home and abroad have carried out rich research, from single target tracking, multitarget tracking, and multicamera multitarget tracking. Multicamera multitarget tracking has the advantages of obtaining large image acquisition area, solving occlusion, illumination change, and so on, but there are difficulties in multicamera data fusion and target matching [5, 6]. Some researchers have proposed a regional target matching method, which uses target features to match multiple cameras. Some researchers realize target matching based on color features and establish a Gaussian color model to match the target through the color histogram as the matching feature [7, 8]. However, when the target color is similar, the matching is easy to produce errors. At the same

time, when the light changes, the color will change and there may be great differences in the color of the same target, which greatly affect the target matching [9]. Some researchers propose to match based on the feature points of the target [10]. By taking the centroid of the target as the feature point and establishing a three-dimensional coordinate system, the position of the target is determined. Some scholars have proposed using SIFT features for target matching, which can effectively solve the impact of changes such as illumination, rotation, and reflection [11–13]. However, the feature extraction time is long and the algorithm requirements are very high. At the same time, the more the number of targets, the greater the calculation pressure.

With the development of computer vision technology, video target tracking has become a hot research field, but there are few mature algorithms [14]. This is because target tracking is greatly affected by the external environment, such as motion state, occlusion, and light, so it is very difficult to achieve fast processing speed and accuracy. With the maturity of deep learning technology, the target tracking algorithm based on deep learning is developing rapidly, and the accuracy is guaranteed [15]. Deep learning is a branch of machine learning, in which “depth” refers to the number of network layers in the neural network model. Some researchers use the method of deep learning to improve the accuracy of crack target recognition, which is 10% higher than the traditional method. Therefore, the model of deep convolution neural network gradually replaces the traditional image classification algorithm [16]. Some researchers have proposed the RCNN deep neural network model, which extracts the target area through selective search, uses the RCNN network model to extract the target features, obtains the detection frame through the trained SVM classifier classification and non-maximum suppression algorithm, and achieves good target detection results. However, when multiple targets need to be detected at the same time, the RCNN runs slowly, which affects the detection effect; by improving the RCNN algorithm, some scholars have proposed a new network structure spp net, which greatly improves the running speed by transforming images of different sizes into feature vectors of fixed dimensions and only needs one RCNN target feature extraction [17]; on the basis of RCNN and spp net, some researchers proposed fast RCNN, which realized end-to-end training by adding softmax layer instead of SVM classifier. Some researchers have proposed the full winder RPN network, which can input the whole image and output the rectangular box containing the target [18]. At the same time, it can cover the whole image by using a variety of different sliding windows, and each sliding window can get the results of the probability and position regression of the target. In this paper, a set of multicamera multitarget tracking system is designed, which can accurately track multiple athletes for a long time by collecting the athletes’ stadium competition images. A multicamera multitarget tracking system is established. The KCF algorithm and the KCF improved algorithm are used to analyze the impact of different target tracking ranges and target numbers on the target tracking accuracy of the system, so as to achieve the soccer players’ video target tracking under the deep learning.

2. Research Method

2.1. Multicamera Multitarget Tracking Method. By tracking the players in the football video with a single camera, the area covering the football field is incomplete and the players will sometimes disappear and sometimes appear in the camera, which is prone to number matching errors. This paper adopts multicamera and multitarget tracking, collects the whole stadium through multiple cameras, processes the collected image data, and uses multiple cameras to obtain target information to ensure that the players are in the field of vision. The targets between multiple cameras can be corrected each other, when the number matching error of a player in one camera can be corrected by other cameras and finally the correct player can be matched back.

In football video, player tracking needs to obtain the trajectory of all players. Firstly, the coordinate system of each camera and the court and the mapping relationship between them should be established. At the same time, the camera position is fixed and the mapping relationship can be realized through camera calibration. The process of camera calibration (Figure 1) is as follows:

- (1) Install 12 cameras on the football field. The installation position is shown in Figure 2. Set the height and focal length to ensure that they can cover the whole football field.
- (2) Use the calibration plate to rotate the camera in different directions to ensure that the calibration plate can appear in all positions of the camera. At the same time, select 20 clear images and use Zhang’s calibration method to calibrate the internal parameters of the camera.
- (3) Simulate the movement of football, place the football with different colors from the football field, take one of the four corners of the football field as the origin of the coordinate system, and record the coordinates of the projection of the football center under the field coordinate system.
- (4) According to the image with football taken by the camera, the color is used to distinguish the football and the field and the coordinates of the football in the image are calculated.
- (5) The corresponding relationship between the pitch coordinates of football and the pixel coordinates in the image is obtained by calculating the internal parameter matrix and external parameter matrix.
- (6) Through the internal and external parameters of the camera, the pixel coordinates of the football are converted into coordinates. According to the error between the converted coordinates and the real recorded coordinates, the image is divided into regions to compensate the pixel coordinates.

2.2. Multicamera Fusion Algorithm. Through the multicamera fusion algorithm, the individual target tracking results of multiple cameras in a complete video sequence are

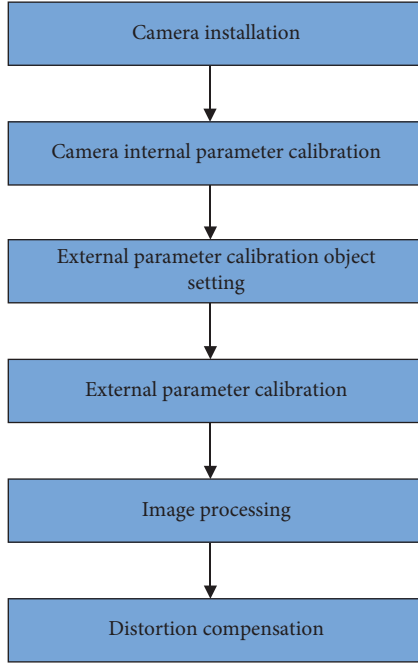


FIGURE 1: Camera calibration process.

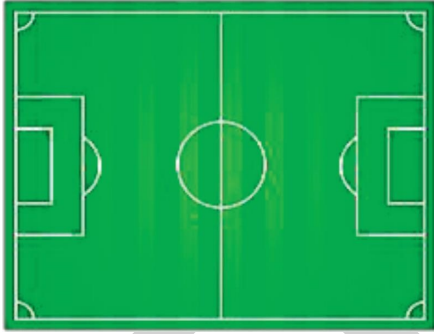


FIGURE 2: Camera installation location.

converted to each corresponding athlete through coordinate transformation. In order to improve the accuracy of fusion, a triple matching method is adopted, which uses historical information correspondence, nearest neighbor algorithm matching, and template matching.

Historical information matching is a mapping relationship, that is, the mapping between the target number under each camera and the real athlete number. The nearest neighbor algorithm line matching is measured by the target distance between the end position and the start position of the adjacent cycle to achieve the nearest neighbor algorithm matching. Template matching is to match objects by calculating the similarity between two images. After triple matching, the normalized correlation matching method is selected to realize multicamera fusion.

2.3. Multicamera Multitarget Tracking Algorithm Based on Deep Learning. In order to collect the images of the players in the stadium in real-time and output the motion

trajectories of the players in the stadium, the tracking of the players in the game is decomposed into multiple continuous tracking cycles. Each tracking cycle inputs a video clip (including continuous images of N frames, n is a constant), so as to save the motion trajectories of all players in this video clip and collect all tracking cycles to obtain the motion trajectories of all players in the whole game.

The multicamera multitarget tracking process is as follows:

- (1) For each tracking cycle, the N frames of images collected by a camera are input into the single-camera multitarget tracking module to obtain the initial position of each athlete. The movement track of athletes is fused with the movement track photographed under the camera of the previous cycle to obtain the movement track of each athlete and the target is numbered and saved. Repeat this operation for each camera to obtain the image motion track and its number of all athletes in the current cycle.
- (2) The player's image coordinate trajectory is mapped to the court coordinate trajectory, and the court coordinate trajectory of each player in this tracking cycle is obtained by the multicamera fusion algorithm. The data collected by multiple cameras can be synchronized with the data collected by multiple cameras in the next cycle. In the calculation process, the football is a fixed target. If the field coordinates of the football calculated by multiple cameras differ greatly, the single camera module has a target tracking error and the track can be deleted. At the same time, the volume of the football is small, the tracking is difficult, and it may be blocked frequently. There is no connection between the detected football trajectory. The missing ball trajectory between the two cycles is supplemented by linear interpolation. When the interval between the two weeks is large, the motion trajectory of the ball is kept missing.

The operation flow of the multicamera multitarget tracking method (Figure 3) is as follows: when the algorithm starts to run, 13 threads are run for parallel processing, the first six and the last six threads are used for image acquisition and singlecamera multitarget tracking, and the seventh thread runs the multicamera data fusion algorithm and integrates the data of the previous tracking cycle. Through cyclic processing, it will be completed automatically or manually.

3. Results and Analysis

3.1. Design of Multicamera Multitarget Tracking System. Through the deep learning algorithm, the multicamera multitarget tracking system can process the athlete's trajectory images collected by multiple cameras, extract the trajectory of each athlete and football, and store it in the database in the form of points. At the same time, the system also needs to have the function as shown in Table 1.

The system design is mainly divided into input layer, single-camera multitarget tracking module, multicamera

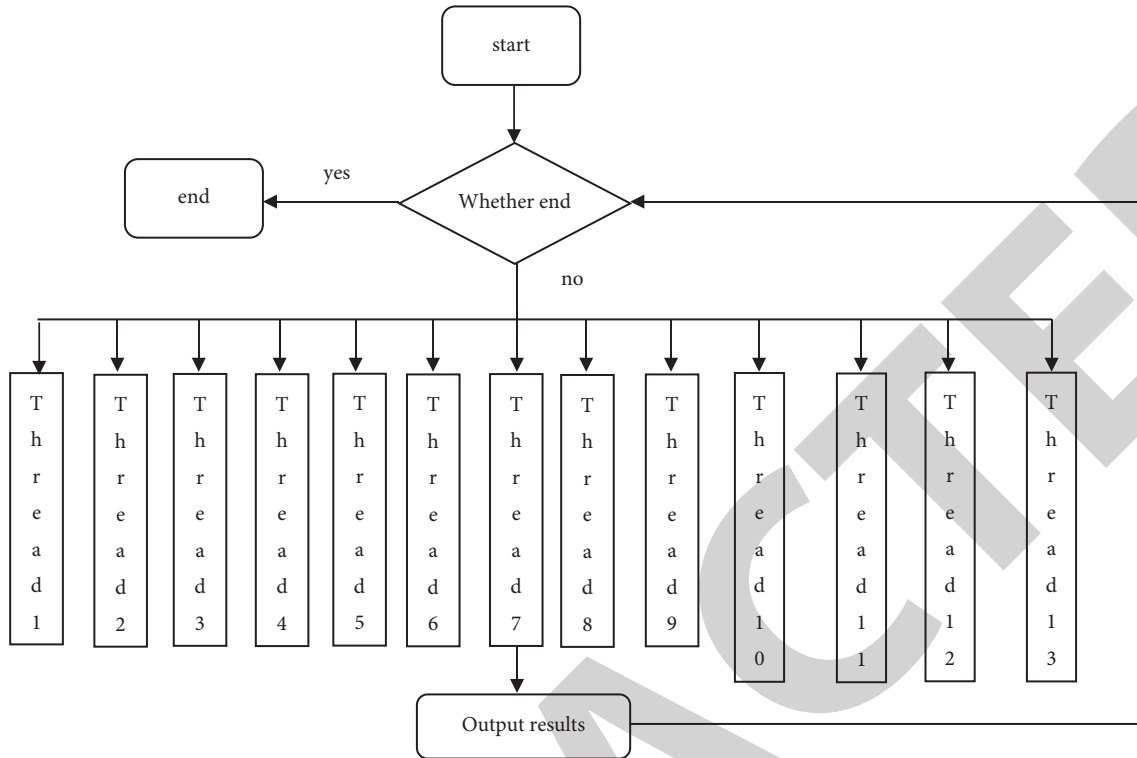


FIGURE 3: Operation flowchart of the multicamera multitarget tracking method.

TABLE 1: System function description.

| System name | Function description |
|---|--|
| Multicamera multitarget tracking system | Real-time: the running speed of the program should exceed the image acquisition speed to avoid memory explosion. |
| | Robustness: the program should have high robustness, be able to deal with some interference, and ensure accurate tracking. |
| | Accuracy: the target position determined by the program is not far from that visible to the naked eye. |
| | Modularization: each module of the program is independent, which is convenient for later optimization and upgrading. |

data fusion layer, and output layer. The input layer mainly inputs the image collected by the camera into the system. The single-camera multitarget tracking module realizes multitarget tracking for each camera to collect images. The multicamera data fusion layer corresponds to the fusion of camera multitarget tracking data with athletes. The output layer is to save the athlete's trajectory data to the database for motion analysis and key event analysis. Among them, the single-camera multitarget tracking module and the multicamera fusion module form a multicamera multitarget tracking algorithm.

The KCF algorithm, which is mainly used in single-camera multitarget tracking, has fast processing speed and high accuracy and can meet multitarget tracking. However, only through the deep learning algorithm, the RGB information of the image cannot be processed. At the same time, it is difficult to deal with the overlapping and occlusion problems in target tracking. The image retrieval of the KCF algorithm adopts hog feature, and its tracking frame is rectangular. When the shape of the tracking target changes,

the difference between the color and the model becomes larger, which is easy to track failure. In order to improve the accuracy of target detection, the convolutional neural network CNN is used to extract target features and the hog feature used by the KCF algorithm is replaced by the deep convolutional neural network. The improved KCF algorithm adds 5 layers of the convolution layer. The specific process is as follows: using the data sampling of the first frame, the position characteristics of conv3, conv4, and conv5 targets are obtained, and three correlation filters are trained. In the second frame, the conv3, conv4, and conv5 of the target are obtained centered on the prediction result of the first frame. Then, we interpolate the target features, calculate the maximum response point on the confidence score through the filter results of conv5 layer, predict the target position layer by layer according to the order of convolution layer, and finally output the target position prediction results, so as to greatly improve the processing speed. Because it uses the deep learning framework to optimize the features, the target tracking accuracy is improved.

TABLE 2: Information processing speed of the KCF algorithm and improved KCF algorithm.

| Algorithm | | KCF algorithm | Improved KCF algorithm |
|------------------------|-----------------------------|---------------|------------------------|
| Single-target tracking | Video consumption time (s) | 24 | 120 |
| | Time consumed per frame (s) | 0.2 | 1 |
| Single-target tracking | Video consumption time (s) | 36 | 240 |
| | Time consumed per frame (s) | 0.3 | 2 |

TABLE 3: Single-target tracking accuracy of the KCF algorithm and the improved KCF algorithm.

| Tracking frame range (mm) | KCF algorithm (%) | Improved KCF algorithm (%) |
|---------------------------|-------------------|----------------------------|
| 20 × 45 | 75 | 73 |
| 34 × 81 | 70 | 67 |
| 48 × 106 | 88 | 85 |

TABLE 4: Multitarget tracking accuracy of the KCF algorithm and the improved KCF algorithm.

| Tracking frame range (mm) | KCF algorithm (%) | Improved KCF algorithm (%) |
|---------------------------|-------------------|----------------------------|
| 20 × 45 | 60 | 85 |
| 34 × 81 | 72 | 92 |
| 48 × 106 | 83 | 98 |

3.2. Experimental Result. The experimental equipment adopts graphics card NVIDIA 1080, CPU i7-6600, and memory 16g. The KCF algorithm and the improved KCF algorithm are used to test the information processing speed of single-target and multitarget. The video duration is 5 seconds and a total of 120 frames. The test results are shown in Table 2. It can be seen from Table 2 that for single-target tracking, the KCF algorithm consumes 24 seconds, 0.2 seconds per frame, and the improved KCF algorithm consumes 120 seconds, with an average of 1 second per frame. For multitarget tracking, the KCF method consumes 36 seconds, with an average of 0.3 seconds per frame, and the improved KCF method consumes 240 seconds, with an average of 2 seconds per frame.

According to the test results in Table 2, when tracking a single target, the KCF algorithm can track the target faster because of less calculation times and no repeated loading. The improved KCF algorithm belongs to the deep learning algorithm, which requires high computer performance and many calculations at the same time. The target tracking speed is obviously lower than that of the KCF algorithm.

The size of target tracking frame affects the speed of information processing. This paper tests the specific target according to the actual size of the tracking frame. The test video is 5000 frames in total. The tracking target is 5 groups of single players and 5 groups of 2 goalkeepers who are blocked. Select 100 frames of video for small range (20 mm) × 45 mm), medium range (34 mm) × 81 mm), and large range (48 mm) × 106 mm), and compare the target tracking accuracy of the KCF algorithm and the KCF improved algorithm (Table 3). It can be seen from Table 3 that with the increase of the range of target tracking frame, the target tracking accuracy of the two algorithms decreases first and then increases. The target tracking accuracy of the KCF algorithm is still higher than that of the KCF improved algorithm, but the difference is small.

Select 100 frames of video for small range (20 mm) × 45 mm), medium range (34 mm) × 81 mm), and large range (48 mm) × 106 mm), and compare the target tracking accuracy of the KCF algorithm and the KCF improved algorithm (Table 4). It can be seen from Table 3 that with the increase of target tracking frame range, the target tracking accuracy of the two algorithms gradually increases. The target tracking accuracy of the KCF algorithm is far lower than that of the KCF improved algorithm, and the multitarget tracking accuracy of the KCF improved algorithm is higher than 85%.

According to the test results, it can be concluded that with the increase of the tracking frame range, the accuracy of target tracking is improved and multitarget tracking is helpful to improve the antiocclusion ability of the system. This is because when the target tracking frame is large, there is more target feature information in the area. When the target moves, other features are also included in the tracking range, which can effectively solve the problem that the target cannot be tracked due to the rapid movement of players and improve the antiocclusion ability. The accuracy of the KCF algorithm is higher, while the improved KCF algorithm with deep learning has higher accuracy. However, due to objective reasons, the accuracy of target tracking cannot reach 100%.

4. Conclusions

- (1) With the rapid development of the deep learning tracking algorithm, the real-time and accuracy of target tracking have been greatly improved. Taking the video target tracking of football players as the research object, this paper adopts multicamera and multitarget tracking to collect the motion trajectories of multiple players on the court, processes the collected video images, and uses multicameras to obtain

Retraction

Retracted: Research on the Significance of Big Data and Artificial Intelligence Technology to Enterprise Business Management

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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, "Research on the Significance of Big Data and Artificial Intelligence Technology to Enterprise Business Management," *Mobile Information Systems*, vol. 2022, Article ID 7639965, 10 pages, 2022.

Research Article

Research on the Significance of Big Data and Artificial Intelligence Technology to Enterprise Business Management

Haibo Li ^{1,2}

¹University Malaysia Sabah, Sabah 89000, Malaysia

²Huanghe Jiaotong University, Jiaozuo 454950, China

Correspondence should be addressed to Haibo Li; 2015081609@zjtu.edu.cn

Received 11 May 2022; Revised 1 June 2022; Accepted 8 June 2022; Published 5 July 2022

Academic Editor: Amit Gupta

Copyright © 2022 Haibo Li. 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 continuous development of information technology, China has officially entered into the era of big data, the enterprise business management has realized intelligent business management based on information technology, and the arrival of the era of big data has to some extent reduced its management and risk costs and improved its work efficiency and economic benefits, but at the same time, it also faces a series of challenges, such as with the continuous expansion of business scope. As the business scope continues to expand, its current management model cannot meet the development needs. The integration of artificial intelligence technology and enterprise business management has become the main trend of future development. The application of big data technology to corporate business management enables the production of products and the creation of product value in the direction of socialization, increases the mutual influence between companies and consumers, and enhances the fairness, openness, and justice between corporate development and consumer activities. In this paper, after a detailed understanding of the current situation of the combination of artificial intelligence technology and enterprise business management, we focus on the application path of artificial intelligence technology in enterprise business management and finally elaborate the future development direction of artificial intelligence technology in the field of enterprise business management, hoping to further deepen the relevant personnel's understanding of artificial intelligence. Analyzing the current situation of business management development in China, this paper proposes applying big data technology and artificial intelligence technology to enterprise business management work and proposes a new model to bring new development opportunities and development directions for enterprise business management work. The big data technology proposed in this paper is based on cloud platform services, while artificial intelligence based on neural network is embedded in the cloud platform for enterprise business management services.

1. Introduction

With the promotion of Internet technology and information technology, big data technology has emerged as an important technology in the development of modern society and has greatly contributed to the development of China's economic construction. Compared with traditional data forms, big data technology has three specific aspects: fast generation speed, complex data types, and large data volume, which brings huge development opportunities for many business fields such as e-commerce, human resources, and marketing and sales in China and introduces Chinese business to a brand-new development stage [1–3].

The development status of business management in the context of big data, enterprise production, and creation tend to socialize the use of big data technology to enterprise business management. By using big data to change the way information is generated and disseminated, the relationship between enterprises and consumers is gradually moving toward a balanced state, increasing the mutual influence between enterprises and consumers, and enhancing the fairness, openness, and justice between the development of enterprises and consumer activities. The data and information created by Internet users are the basic means of generating massive amounts of information on the Internet, effectively replacing the traditional “closed” management model, increasing the interactivity between the production

activities of enterprises and consumer activities, and allowing consumers to participate in the management of enterprise business processes using the Internet platform. Enterprise operation and ecology tend to dynamic use of big data technology to enterprise business management, so that the enterprise operation and ecological operation develop gradually towards the direction of network, information technology, dynamic development. From the current situation of enterprise management, the “network ecosystem” formed by social media, network people, cooperative enterprises, and competitors, the system has a greater impact on modern enterprise production management and business management, so that enterprise production management and enterprise business management gradually show horizontal and vertical joint. The system has a greater impact on modern enterprise production management and business management, so that enterprise production management and enterprise business management gradually show two kinds of development situation: horizontal and vertical joint [4–6]. First, from the perspective of horizontal alliance, the networked business model can change the competition mode between enterprise organizations, enhance the cooperation between enterprises in different regions, and gradually form “enterprise alliance” or “virtual enterprise”; second, from the perspective of vertical alliance, enterprise groups are connected by industrial supply chains, increasing the connection between related enterprises, and the mutual benefit and symbiosis among enterprises, so that the supply chain gradually develops in the direction of value chain and eventually transforms into a network ecological chain. The application of big data technology to business management enables enterprises to gradually develop their market demand in the direction of precision and real time, enabling them to make full use of the massive information in the Internet platform to provide a reliable theoretical basis for their decision-making work. Influenced by the Internet technology, enterprises can use the Internet technology to record various information of this enterprise, comprehensively collect customer behavior information, realize the quantification of enterprise performance assessment work, and improve the accuracy of enterprise decision-making information; influenced by the development of the times, consumer idiosyncrasies have changed greatly. The company’s products are trimmed and reorganized according to the development trend of the times and the actual needs of consumers [7–9]. The connotation of enterprise business management is shown in Figure 1.

The rapid development of artificial intelligence technology in China in recent years is closely related to the breakthroughs in technologies such as cloud computing and big data, as well as the development of chip technologies such as NPU and CPU. In order to better adapt to the future development requirements of enterprise business management, AI technology will be further developed in the field of enterprise business management in the future, which will eventually make enterprise business management more adaptable [10]. And in this general environment, the combination of artificial intelligence and enterprise business management will reflect more demand-oriented features, not

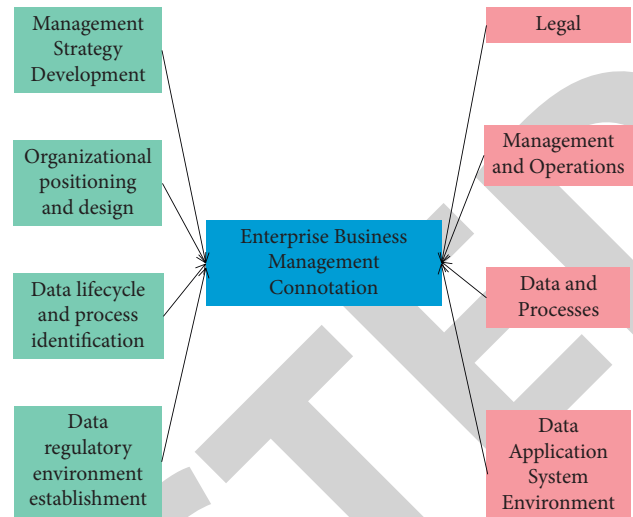


FIGURE 1: Enterprise business management connotation.

only to focus on the interaction of various types of financial information, but also to focus on the consumer’s product experience, not only to improve transaction efficiency, but also to reduce operating costs. Therefore, from the point of view of future development, artificial intelligence technology allows enterprise business management services and products to further close to the user scene, understanding the needs of users and constantly introduce practical solutions to meet the needs of different users rather than just a technical product, and therefore can achieve a significant breakthrough in technology which is because most of the enterprise business management products have the characteristics of stable commodity prices and uniform quality specifications, so the function of artificial intelligence at this time is mainly reflected in the direct operation of the operation. In contrast, enterprise business management is more concerned about the quality of services, so that artificial intelligence technology has a broader space for development, which will become the main trend of future development. To analyze the current situation of business management development in China, this paper proposes applying big data technology and artificial intelligence technology to enterprise business management and proposes a new model to bring new development opportunities and development directions for enterprise business management [11]. The main contributions of this paper are summarized as follows: (1) after a detailed understanding of the current situation of the combination of artificial intelligence technology and business management, we focus on analyzing the application path of artificial intelligence technology in business management and finally elaborate the future development direction of artificial intelligence technology in the field of business management, hoping to further deepen the understanding of artificial intelligence by the relevant personnel. Hope to further deepen the understanding of artificial intelligence technology; (2) analyzing the current situation of the development of enterprise management in China, this paper proposes to apply big data technology and artificial intelligence technology to enterprise management work and

proposes a new model to bring new development opportunities and development directions for enterprise management work. (3) It proves the effectiveness of the proposed method in the relevant data set, which can be applied to the actual enterprise management.

2. Related Work

2.1. Corporate Business Management. Enterprise business management is a comprehensive organization, planning, leadership, innovation, and control of activities of selling and purchasing economic resources based on profit-making business organizations and natural persons, with various characteristics such as human-oriented, outward-looking, changeable, global, and complex. Enterprise business management is a mode of integrated management, which is the condensation and practice of project in modern enterprise business management, covering the whole process of project management implementation, from the initial contact with the project, bidding, signing contracts, pre-planning and selection of options, signing sub-contracts, to cost control during the implementation of the project, the collection and management of progress payments, completion settlement verification and determination, recovery of warranty, and the whole process of financial finalization whole process. Enterprise business management is an applied discipline based on theories of business communication, the basic theory of international trade and commerce and its affairs, marketing, economic management, and many other disciplines. It is required that business management personnel should have various skills such as information processing, special technology, interpersonal skills, a strong theoretical foundation, foreign language proficiency, and the ability to independently acquire knowledge, propose analysis, and solve problems [10–13]. From the microscopic point of view, enterprise business management means applying the methodology of enterprise business management to the project and controlling project funds; from the macroscopic point of view, enterprise business management has a wide range of contents and is the management practice of the overall economic control process of the project, which is the combination of immediate management and capital control. Effective business management is a balance between the business interests of the enterprise and the objective conditions: firstly, it maintains the overall management of the enterprise based on contract management; secondly, it seeks to balance and develop the modern enterprise by properly dealing with the problems that cannot be dealt with by contract through business skills and strategies. Therefore, business management must be based on the overall interests of the enterprise and adhere to the basic principle of organic integration with technical management. If enterprise business management is the practice of enterprise business management at the grassroots level, then the project is the basic carrier of enterprise business management. Enterprise business management needs to be implemented from the seven major aspects of project contract, capital, cost, procurement, claims and anti-claims management, risk management, completion of settlement, coordinated by the

business manager, led by the project department, all departments to participate and complete business planning, preparation of contracts, review, implementation, adjustment, cost measurement, control and analysis, the assessment and restoration of the work, and ultimately the preparation of the settlement, review. Finally, all the processes of business management such as preparation of settlement, evaluation, reporting, settlement, and assessment will be implemented well [14–16].

First, during the specific implementation of the work of enterprise business management, it is required to sort out the relationship between all parties, and if there is a dispute during the implementation of the contract, the enterprise business manager and the project manager will build a communication channel together, and the leaders of both sides will implement business negotiations, and business negotiation will be the preferred solution to the dispute; second, enterprise business management is a comprehensive management work, which can not only build external communication channels, but also to strengthen internal communication. A good business management can realize the whole process of business management through close cooperation with the technical departments of the enterprise, so as to promote the efficient implementation of the work of business management. Effective implementation of special planning business personnel should do a good job in the early stage of the project to access a variety of resources, including technical support, material assurance, qualification permits, financial support, etc., in order to obtain the feasibility of the project planning, and the planning program requires the collection of project managers and technical experts, to ensure that the premise of close cooperation between various departments and the implementation of the work to effectively promote the project until the project will be in line with the strategic objectives of business management [17–19].

2.2. Big Data and Artificial Intelligence. Enterprise production plans, goods warehouse storage, raw materials, and other information together constitute the enterprise internal data, which is an important content of enterprise knowledge exchange and has an important influence and development value for the enterprise's later development. By using big data technology to implement integrated management of enterprise development business, enterprises can link warehouse storage system, human resource management system, and enterprise resource planning system together organically to realize integrated management of enterprise information, optimize enterprise business process, improve enterprise business management efficiency, and enhance the competitiveness and development power of enterprises in the market development. Under the influence of big data technology, enterprise external data information is divided into two types, namely, enterprise information and market environment information. First, the enterprise's own information mainly refers to the information involved in many aspects such as product production, product supply, product trading quotation, product orders, etc.; second, the market

environment information mainly refers to the various types of information generated by the market environment faced by the enterprise in the development process, such as product market demand information, customer purchase satisfaction information, national policy information, raw material market price information, etc. Influenced by the traditional enterprise business management concept, the management of information inside and outside the enterprise is relatively independent. Applying big data technology to modern enterprise business management can integrate the information inside and outside the enterprise, realize the centralized management of enterprise information, enhance the cooperation and communication among enterprises, and strengthen the competitiveness of enterprises in the market development. The integration of big data and enterprise business management is shown in Figure 2.

The development strategy of enterprise business management under the background of big data focuses on talent training to promote the development of enterprise business management, to ensure that big data technology can be flexibly used in enterprise business management. First of all, all departments of the enterprise should raise the importance of talent training and improve the professional skills of enterprise business managers through regular professional e-commerce training for enterprise business managers; secondly, enterprises should use big data technology to build their own business platform in the network system, enhance the communication and exchange of all departments in the business platform, and enhance the practical application ability of enterprise employees to e-commerce technology. Enterprises should constantly improve the supporting facilities, provide material basis for talent training, and build a strong e-commerce talent team, as well as improve the capital structure to meet the trend of development of the times and keep pace with the market development [20, 21]. First of all, enterprises should build a network interactive platform by using the network platform, increase the communication and exchange between enterprises and consumers, timely understand the actual needs of consumers, accurately lock the target group, reduce the blindness of enterprise design, production, and marketing, and reduce the risk of market operation; secondly, enterprises should start from the existing marketing model and network consumer groups, build a marketing model and network consumer groups between the operation mechanism, according to the consumer groups in different fields, develop the corresponding operation structure, and improve the relevance, scientific, and usability of enterprise business management work.

At this stage, China's artificial intelligence technology in the field of enterprise business management is mainly concentrated in the field of ERP, which is because most of the enterprise business management products have the characteristics of stable commodity prices and uniform quality specifications, so the function of artificial intelligence at this time is mainly reflected in the direct operation of the operation. In contrast, enterprise business management is more concerned about the quality of services, so that artificial intelligence technology has a broader space for

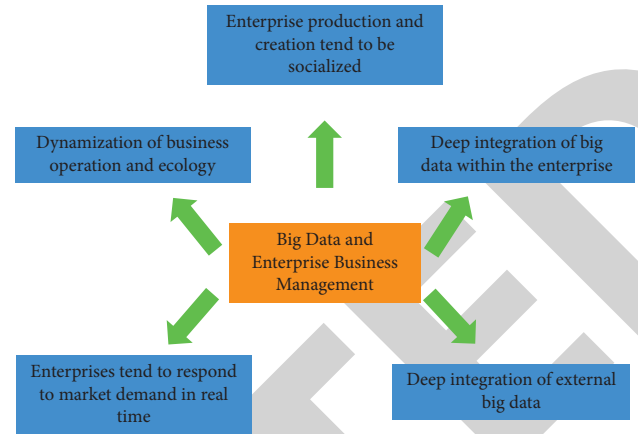


FIGURE 2: Big data and enterprise business management integration.

development, which will become the main trend of future development. The combination of artificial intelligence technology and enterprise business management has a broad development prospect, so the future work should actively explore the new path of artificial intelligence technology development, the advantages of artificial intelligence technology, so as to comprehensively improve the overall development of enterprise business management [22, 23].

3. Methods

3.1. Model Architecture. Enterprise management information system is the use of modern management ideas and means, with the help of modern information network and other technologies, to collect, organize, and store all kinds of information generated in the daily operation and management of enterprises, to provide a reference basis for the preparation and selection of various business management work and related decision-making programs. The establishment of enterprise management information system needs to start from the business processes involved in the enterprise, although the business processes of each enterprise are different, but for the production enterprises, the business processes involved include product development, material procurement, production processing, and other links. Enterprise management includes material management, production management, and other aspects of management, so it is important to establish a management information system through the analysis of the overall business process of the enterprise. With the continuous development of social economy, the competitiveness among enterprises is becoming more and more fierce. Enterprises pay more attention to the intimacy of customers, and it is important to strengthen the communication and interaction with customers and maintain good customer relationships. At the same time, in the face of the growing e-commerce, enterprises need to update their operation mode and conduct comprehensive analysis of relevant management data and information, to lay the foundation for better enterprise decision-making management. Therefore, to meet the enterprise management requirements, when establishing the

management information system platform, it is necessary to pay attention to various management tasks such as customer management. The schematic diagram of the model structure is shown in Figure 3.

3.2. Cloud Computing and Virtual Technology. Cloud computing is an application provided on the network platform, that is, the hard and software that provide services. Cloud computing has the following characteristics: (1) hard and software are resources, which provide services to users using the form of web services; (2) such resources are capable of dynamic expansion; (3) such resources exist in the form of sharing, but finally they are presented as a single whole. In cloud computing systems, virtualization is a very critical technology, which is a virtual version created for a certain thing or scenario. In this technology, the objects that are virtualized are various types of IT resources. The IT resources based on cloud computing system and the traditional management system are different, under the platform includes three levels of infrastructure equipment, platform, and application layer. Among them, the infrastructure equipment layer takes the hardware resources of the cloud as the core and virtualizes various hardware resources using virtual technology. Before building the infrastructure equipment layer, it is necessary to build a data center, in which there are many servers and other related hardware resources to be networked. In order to manage resources more effectively, it is necessary to complete the setting of the virtual scheme in combination with enterprise management information requirements, realize the virtualization of all kinds of hardware resources in the data center, build the corresponding virtual platform, and then realize the management of all kinds of data through virtual integrated management equipment. After the construction of the basic equipment layer, it is possible to carry out basic equipment layer services, including a number of management services such as user management. These services allow users to access the infrastructure layer resource interface, which facilitates more efficient use of infrastructure resources. Using the infrastructure layer can improve the utilization of IT resources, reduce the cost of various types of equipment, and facilitate more effective management of IT resources. The purpose of the platform layer is to provide users with various environments for development and application testing and operation. This includes programming languages, API code libraries, and so on. In this platform layer, it can be used to provide software developers with development and application environments in the form of online and offline development environments, where the online development environment needs to be carried out on the server side and developers do not have to design and develop software, while the offline development environment can support developers to do testing locally. When the testing is completed, the developer needs to deploy the application and transfer it to the cloud platform, which configures the application and activates it so that the application can run smoothly. When the application is officially running, the platform must monitor the application comprehensively. The application

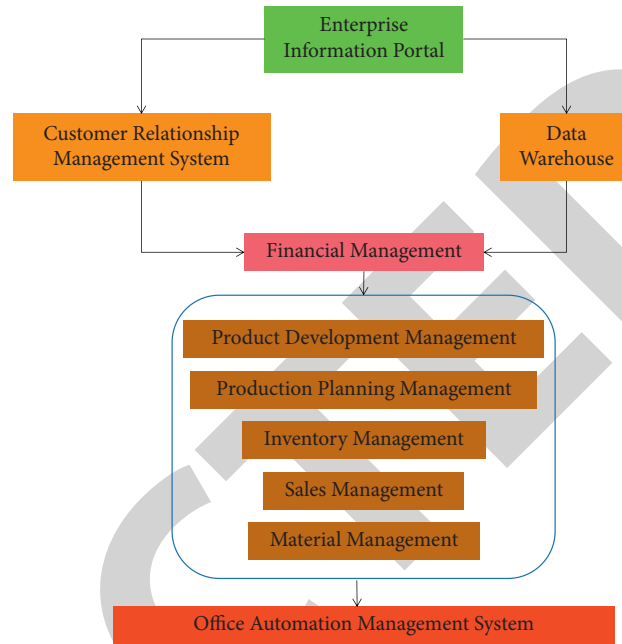


FIGURE 3: Schematic diagram of the model architecture.

layer is a collection of various applications running in the platform, such as financial control system, inventory control system, and other management systems.

The establishment of management information system must be combined with the actual needs of enterprise information management and all kinds of application load to be scientifically analyzed and make the right judgment, to see which applications are suitable for cloud computing services, which applications are suitable for cloud migration, etc. By integrating the classification of various types of application loads and combining the characteristics of application loads, the types of loads applicable to public and private clouds for each application of the enterprise are determined. For enterprises, their internal management information contains various applications such as finance and products, which can be set up on private clouds, while the management information system software adapted to them needs to be set up on private clouds using cloud migration means. Big data and enterprise business management is shown in Figure 4. The proposed cloud computing model mainly includes application layer, platform layer services, and infrastructure layer services. Among them, the infrastructure layer services consist of virtualization integration managers, virtual machines, etc. To establish a complete cloud computing platform adapted to the needs of the enterprise, it is necessary to integrate and reconfigure its internal resources with the specific situation of the enterprise, and combined with the application load requirements, design the corresponding virtual solutions, including server and network virtualization, and then establish business templates, scientific deployment of each business, and ensure the security configuration of each business. In addition, it is necessary to combine the requirements of the system application software for the environment, use the platform layer to provide users with an operating environment that adapts to their

needs, and migrate the corresponding application software and set it up on the application layer to provide users with a management solution that includes each operating system and business layer.

3.3. Artificial Intelligence Algorithm. To realize the error correction of enterprise business management data, it is necessary to detect the amount of error in enterprise business management accounting data. Therefore, this paper proposes a neural network-based error correction of enterprise business management accounting data. Assume that the enterprise business management accounting data set is set as

$$W = [w_1, w_2, \dots, w_n] \in R^+, \quad (1)$$

where W represents the composition factor in the data set and n denotes the number of accounting data in the data set. The error U within the accounting and financial accounting data detection set is expressed as

$$U = [u_1, u_2, \dots, u_m], \quad (2)$$

where u represents the accounting data detection factor. Before the accounting and financial accounting data error detection, decompose W and obtain

$$W = HH^T, \quad (3)$$

and convert the data set into another form as follows:

$$W_c = H^{-1}W = H^{-1}U + H^{-1}E, \quad (4)$$

where H represents the lower triangular matrix and E represents the expectation value. Calculate the variance matrix of W . Define the expected value as

$$E_{W_c} = \frac{1}{n}W_c W_c^T. \quad (5)$$

The singular value decomposition of W_c into the first m - ν singular values and the last ν singular values is expressed as

$$W_c = \frac{\sqrt{n}Z D v_c^T}{U_c}, \quad (6)$$

where Z denotes the orthogonal input basis vector composed of W columns, D denotes the orthogonal output basis vector, and ν denotes the number of rows of the constraint matrix. The number of minimum eigenvalues approximating to 1 is the value of ν obtained by the above calculation. The error result of the data set can be obtained as

$$U = HX_c. \quad (7)$$

After obtaining the data errors, the convolutional neural network is used to determine the relationships between data, between errors, and between data and errors, and the relationships between data are used as a basis to correct the data errors.

Based on the errors in the financial accounting data detected above, the data classification model is constructed using convolutional neural network, and the financial accounting data is

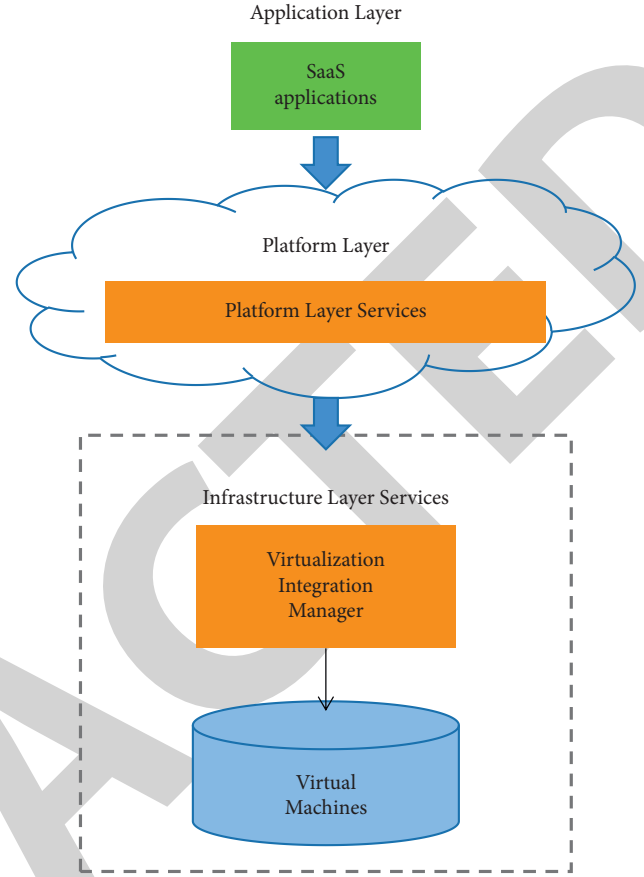


FIGURE 4: Big data and enterprise business management.

used as the input quantity of the model to determine the relationship between variables of financial accounting data by analyzing the feature vectors of the data. In the model, the pooling layer and the convolutional layer are mainly responsible for processing the financial accounting data, and the connection between the convolutional layer and the pooling layer is redesigned in consideration of the specificity of the data relationship. Assume that the financial accounting data input into the model is A , where a denotes the i -th sequence of the data, and use A_i to denote the series sequence matrix a_i , and perform the convolution operation with the data to obtain another vector p denoted as

$$p_j = K \otimes A_{(j-k+1):j}, \quad (8)$$

where $1 \leq j \leq |A| - k + 1$ and K denotes the weight matrix of the convolution layer. Using filters to capture the different features of the input data, the convolution operation of the financial accounting data is expressed as

$$p_{ij} = K_i \otimes A_{(j-k+1):j}, \quad (9)$$

where $1 \leq i \leq n$. The matrix $P = \{p_1, p_2, \dots, p_n\}$ can be obtained by convolving the layers in the model. The matrix P is divided into 3 parts, p_b , and the vector being segmented is obtained by pooling layer processing.

$$\Delta y_b = \Delta_s y_b + \Delta_o y_b. \quad (10)$$

The category label corresponding to data A is obtained by dot product calculation, and the category vector of that

category label is obtained and combined into the category matrix T_A . Based on each data category, the inter-data relationship can be determined. If the data error and the relationship between the data are known, the correction of the data error is realized. Enterprise financial data error correction is implemented. According to the above analysis, the error of financial accounting data is known to be the sum of random error and accounting error, expressed as

$$\eta_{ij} = \max(p_{i,j}). \quad (11)$$

4. Experiments and Results

4.1. Experimental Environment. This experiment uses my hardware and software environment as shown in Table 1.

4.2. Data Set. The sample data are obtained from a regional business database of Chinese enterprises, and the sample time series is from 1993 to 2012. The data indicators contain 82 indicators, including 48 financial indicators, 33 industry or macro indicators, and 1 default indicator. The data sample is 3045 customers, 2995 good customers, and 50 bad customers. No relevant metric screening was performed in this study. First, the neural network has the characteristics of local connectivity and weight sharing, which can effectively avoid the influence of high correlation of indicators; second, it is to ensure the size requirement for input data; third, the reason is because indicator screening is not the focus of this study. The data sample allocation table is shown in Table 2.

4.3. Data Preprocessing and Segmentation. Step1: standardization of original data. The raw data of Chinese small enterprises extracted from the database are standardized to obtain the standardized data set. Standardization processing is not the focus of this study, so it is not described in detail. Step2: unbalanced sample processing. This study uses a MATLAB program to implement the unbalanced sample processing process. The defaulted samples are synthesized into new defaulted samples by SMOTE algorithm, so that the total number of defaulted samples and the total number of nondefaulted samples reach 1:1. Step3: in this paper, the entire sample N is randomly divided into two parts, training sample $N1$ and test sample $N2$. Among them, the test set ratio is divided into 7:3.

4.4. Effect of Convolutional Kernel Depth on Model Discriminative Accuracy. In this study, the highest ACC accuracy was used to invert the convolutional layer core parameters. The convolutional layer of the improved convolutional neural network model contains two, conv1 and conv2. Multiple sets of empirical evidence on the convolutional kernel depth are set separately to explore and compare the convolutional kernel depth. The empirical constant of the convolutional kernel depth of most convolutional neural networks is 128, and this study takes different depth constants in the range of about 128 to get

different training set accuracies and selects the one with the highest accuracy in its training set. The effect of the depth of convolution kernel 2 on the discriminative accuracy of the training set is shown in Figure 5.

4.5. The Effect of Convolutional Kernel Size on Model Discriminative Accuracy. The most important model structure of the convolutional neural network is the convolutional layer, and the convolutional layer has an important parameter, the size of the convolutional kernel, in addition to the depth. The size of the convolutional kernel is related to how many features are captured in each convolutional operation, and it is especially important to select the most suitable convolutional kernel because the features are too vague to be distinguished if they are too large, and the features cannot be distinguished if they are too small. For this study's 9×9 input matrix, four of them are selected to meet the processing requirements, and the optimal convolution and size are inferred with the highest accuracy of the training set, and the same for convolution kernel 2. The sizes of convolution 1 and convolution 2 are explored separately and the comparison results are obtained as follows. The effect of convolution kernel 1 size and convolution kernel 2 size on the discriminative accuracy of the training set is shown in Figures 6 and 7.

4.6. Comparison of Results. In this paper, the entire sample N is randomly divided into two parts: training sample $N1$ and test sample $N2$. Among them, the test set ratio is divided into 7:3. The default discrimination results of the neural network default discrimination model have been obtained, as shown in rows 6 and 7 of Table 3. Comparing the neural network models in Table 3 with other classical models, we can see that the G-mean, ACC, Type error, KS, BM, MK, and AUC accuracy of the neural network models constructed in this paper are significantly higher than the four typical default discrimination models of SVM, NB, LG, and LDA, while the difference between F-value and Type II error and other models is smaller. The training process performance proposed curve is shown in Figure 8.

Comparing rows 6 and 7 in Table 3, the CNN with double Euclidean shortest as the principal arrangement (b) is more accurate than the CNN with random arrangement (a). Also comparing the two rows 5/7, the double Euclidean distance shortest principle proposed in this study is better than the E-value minimum criterion. In summary, the discrimination accuracy of the CNN model in this paper is significantly higher than the four typical default discrimination models of SVM, NB, LG, and LDA; the convolutional neural network model based on the double Euclidean distance arrangement proposed in this paper effectively improves the default discrimination ability. The discrimination accuracy of convolutional neural network model is higher than that of logistic regression model, plain Bayesian, support vector machine, and LDA model. Convolutional neural network is a nonlinear model, so it can give a more relevant description of the factors affecting business management risk compared with the linear approach of models

TABLE 1: Software and hardware environment.

| Name | Parameters |
|------------------------------|--|
| Processor | Intel(R) Xeon(R) CPU E5-2620 v4 2.10 GHz |
| Hard disk | 1T |
| Memory | 16G |
| Operating system | Software |
| Development language | ubuntu |
| Integrated development tools | Java, Python |
| Database | Idea |
| Deep learning framework | MySQL |

TABLE 2: Sample classification table.

| Sample classification | (1) Training sample N1 | (2) Test sample N2 | (3) Test set ratio |
|----------------------------------|------------------------|--------------------|--------------------|
| (1) Number of nondefault samples | $N0 = 2995$ | $n0 = 639$ | 7/3 |
| (2) Number of default samples | $n1 = 2995$ | $n2 = 275$ | |
| (3) Total number of samples | $N1 = 5990$ | $N2 = 914$ | |

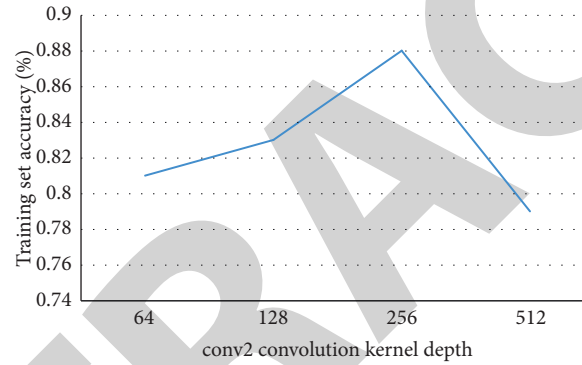


FIGURE 5: Effect of convolutional kernel 2 depth on discriminative accuracy of training set.

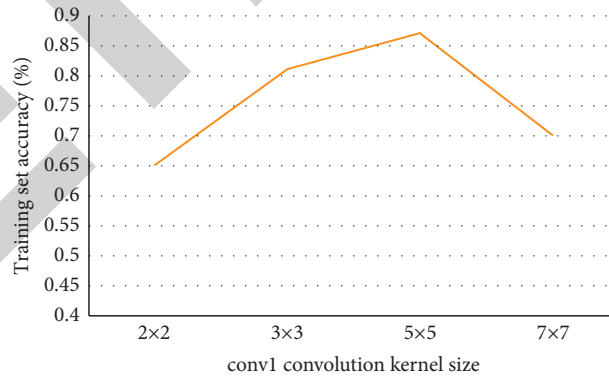


FIGURE 6: The effect of convolution kernel 1 size on the discriminative accuracy of the training set.

such as logistic regression. At the same time, convolutional neural network itself has strong autonomous learning ability, and compared with traditional machine learning models, convolutional neural network is very good at dealing with the classification problem of matrix tensor type

data; therefore, compared with other four traditional models, convolutional neural network model can be more accurate to discriminate enterprise business management risk, and the ability to distinguish good and bad customers is stronger.

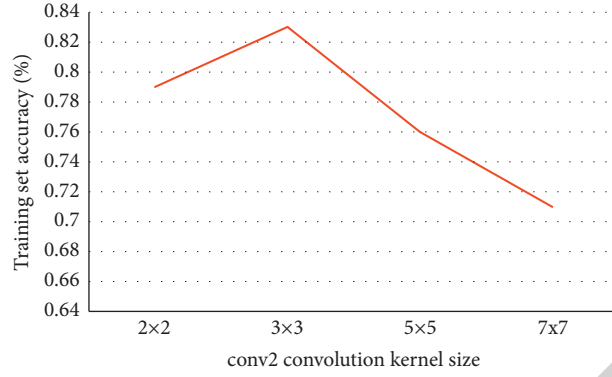


FIGURE 7: The effect of convolution kernel 2 size on the discriminative accuracy of the training set.

TABLE 3: Sensitivity modulation table of the new normal target to the digital economy industry.

| Models | Accuracy | F_measure | G_Means | AUC | KS | BM | MK | II_error | I_error |
|---------|----------|-----------|----------|----------|----------|----------|----------|----------|----------|
| LG | 0.754864 | 0.769231 | 0.752292 | 0.809702 | 0.527341 | 0.509659 | 0.517612 | 0.183333 | 0.307008 |
| SVM | 0.775987 | 0.796773 | 0.769217 | 0.817812 | 0.556337 | 0.551860 | 0.575824 | 0.229222 | 0.325918 |
| NB | 0.713730 | 0.752285 | 0.696553 | 0.757133 | 0.441807 | 0.427287 | 0.472951 | 0.231111 | 0.441602 |
| LDA | 0.780989 | 0.791975 | 0.779202 | 0.820929 | 0.570822 | 0.561921 | 0.568192 | 0.166667 | 0.271413 |
| CNN (x) | 0.812004 | 0.760002 | 0.781114 | 0.841123 | 0.624441 | 0.595883 | 0.601145 | 0.230002 | 0.203336 |
| CNN (a) | 0.800548 | 0.759565 | 0.798004 | 0.854651 | 0.600484 | 0.594844 | 0.599484 | 0.244845 | 0.154005 |
| CNN (b) | 0.856096 | 0.781818 | 0.832865 | 0.903904 | 0.683427 | 0.670455 | 0.678763 | 0.227545 | 0.102000 |

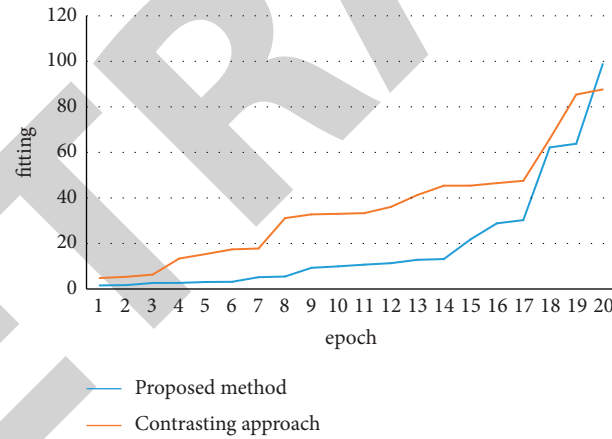


FIGURE 8: Training process performance proposed curve diagram.

5. Conclusion

In summary, with the promotion of computer technology, Internet technology, Internet of Things technology, cloud computing technology, and big data technology have emerged successively, which bring great impetus to modern enterprise business management work and can effectively transform the management concept of modern enterprises in China, refine the operation process of business organization, optimize the enterprise marketing decision scheme, integrate the production mode of consumer behavior, and enhance the directness and intuitiveness of enterprise business. It can effectively change the management concept of China's modern

enterprises, refine the business operation process of industry organizations, optimize the marketing decision plan of enterprises, integrate the production mode of consumer behavior, enhance the directness and intuitiveness of enterprise business management, and promote the development and reform of China's market economy. Through the application of enterprise business management system based on cloud computing architecture, it can not only make up for the shortcomings of traditional enterprise business management system, but also help ensure the timeliness and security of the management system, improve the efficiency of troubleshooting, and enhance the overall performance of the system. Therefore, it is worth promoting and applying the

Retraction

Retracted: Analysis of Syntactic Complexity and Semantic Coherence of Academic English Writing Based on Particle Swarm Optimization

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Li, "Analysis of Syntactic Complexity and Semantic Coherence of Academic English Writing Based on Particle Swarm Optimization," *Mobile Information Systems*, vol. 2022, Article ID 9917832, 9 pages, 2022.

Research Article

Analysis of Syntactic Complexity and Semantic Coherence of Academic English Writing Based on Particle Swarm Optimization

Lei Li 

Zhengzhou Railway Vocational & Technology College, Zhengzhou, Henan 450052, China

Correspondence should be addressed to Lei Li; 10456@zzrvtc.edu.cn

Received 26 May 2022; Revised 11 June 2022; Accepted 21 June 2022; Published 5 July 2022

Academic Editor: Amit Gupta

Copyright © 2022 Lei Li. 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.

Writing is an important part of testing language ability, and it is urgent to find some objective indicators to determine and evaluate the surface language structure, which will help language learners' better master the target language. Complexity and semantic coherence are considered to be an important factor in the teaching of second language writing. In practice, due to the complexity of English writing syntax, such as a large number of high-dimensional nonlinear optimization problems, a new intelligent evaluation method is needed to solve them. At present, particle swarm optimization (PSO) has been widely used in function optimization, neural network training, combinatorial optimization, and other fields. This paper studies the syntactic complexity and semantic coherence of academic English writing based on PSO. The number of phrases is related to writing achievement. When the number of experiments reaches 25, the significant values of syntactic complexity and semantic coherence of data mining algorithm, artificial intelligence algorithm, decision tree algorithm, and PSO algorithm are 0.008, 0.003, 0.002, and 0.013, respectively, which shows that PSO algorithm is the best among them.

1. Introduction

English writing is not only an important part of English teaching but also one of the difficulties of English teaching. There are still syntactic problems in Chinese students' English writing. In recent years, while analyzing the writing performance of language learners, Chinese researchers have completed a series of studies on second language writing. They found that even senior Chinese students show language ability. The characteristics related to oral discourse and the complexity and semantic coherence of simple sentences in their works have made a comparative study on the language characteristics of English writing in Chinese universities and American College Students [1, 2]. Complexity refers to the combination degree of language use, which usually reflects the length of discourse and the subordinate level of use. Syntactic complexity, also known as syntactic maturity or language complexity, refers to the scope of language output forms and the degree of formal complexity. When describing syntactic complexity, the length of output units, the embedding amount of clauses, the scope of structural types, and

the complexity of special structures are quantitative objectives. Writing is an important part of testing language ability. It is urgent to find some objective indicators to determine and evaluate the surface language structure, which will help language learners become more proficient in the target language [3]. Syntactic complexity and semantic coherence are considered to be an important factor in second language writing teaching. There is also research that complex noun phrases can help us use refined phrases to express ideas [4, 5]. Encourage students to simplify subordinate sentences, simple sentences, and compound sentences into phrases. We should consciously use attributives, appositive clauses, and adjective phrases because these languages belong to "noun phrase components", which can increase the noun information density, t unit, and clause length. In addition to t unit and clause length, the index of subordinate clause usage is still one of the keys to improve the quality of composition. Chinese students often use simple sentences, compound sentences, and a small number of object or adverbial clauses in English writing. In writing teaching, we can strengthen the awareness of syntactic complexity through sentence

pattern transformation, help them establish the syntactic system of English complex sentence patterns, and master the flexible and appropriate use of various sentence patterns [6, 7].

In practical application, due to the complexity of English writing syntax, for example, there are a large number of high-dimensional nonlinear optimization problems, which need to be solved by a new intelligent evaluation method. At present, PSO algorithm has been widely used in function optimization, neural network training, combinatorial optimization, and other fields. This paper attempts to apply PSO algorithm to the study of syntactic complexity and semantic coherence of English writing. PSO algorithm forms a temporary clonal population through the individual extremum of each particle and generates a new population after clonal amplification; Cauchy mutation is carried out on individuals in the population to increase the diversity of the population, so as to improve the global search ability of the algorithm [8]. The birds in the swarm are abstracted into “particles” without mass and volume. Through the mutual cooperation and information sharing of these “particles”, their motion speed is affected by the historical motion state information of themselves and the swarm. The current motion direction and speed of the particles are affected by the historical optimal position of themselves and the swarm, which can better coordinate the relationship between the “particles” themselves and the swarm motion. Find the optimal solution in the complex solution space [9]. When selecting the quantitative index of the population, it should reflect the evolutionary characteristics of the population as much as possible, and the time series in the evolutionary process should have a certain law or pattern. Because the growth of learners’ syntactic ability is an integral part of their language ability, her development in the target language is not only used as an oral and written evaluation of language learners and an indicator of learners’ proficiency, which is the basis of their performance, but also used to measure the progress of language. Learning some syntactic complexity is reflected in the changes in syntactic changes, complexity, and semantic coherence in second language writing or speaking, or syntactic scope.

The PSO algorithm initializes the population of syntactic complexity and semantic coherence of English writing by using the idea of label propagation and then uses the comparative mutation strategy to update the speed V according to the state quantity of population extreme value and individual extreme value. Then, according to the value of V , the local iterative search method is used to update the particles in the complexity and semantic coherence population. Finally, the single path crossover operation is used to cross the individual in the population with the individual extreme value [10]. One of the reasons for the decrease of syntactic complexity research is that there is no direct relationship between syntactic complexity and writing quality because there are good and poor short sentences and good and poor long sentences, and the relationship between syntactic complexity and writing quality is also affected by the subject matter. Traditional teaching methods focus on language form and try to control and minimize the

possibility of grammatical errors without paying enough attention to language. Grammatical complexity gradually causes educators and teachers and many language output evaluation schemes to begin to emphasize the requirements of complexity and change [11]. According to syntactic complexity and semantic coherence, it should help the researchers constantly observe and provide a theoretical framework for interpretation; it should lay the foundation for replication and accumulation of experience and understanding of important structures. Carry out a study on the syntactic complexity of writing materials, and the method of measuring syntax should cover syntactic complexity and diversity. Therefore, unit length, clause density, and sentence type are considered as indicators of syntactic complexity. All particles are in English writing syntax. Both have an adaptation value of writing syntactic complexity and semantic coherence determined by the objective function and know the best position and current position they have found so far. This can be seen as the particle’s own flight experience. In addition, each particle in the PSO algorithm also knows the best position of all particles found in the whole group of writing syntactic complexity and semantic coherence, which can be regarded as the peer experience of particles.

In this paper, I mainly put forward the following innovations.

- (1) The particle coding method is proposed in this paper. First, each particle in the network is set into a different community, and then iteration is carried out. For each particle, the community to which all its neighbors belong is recorded, and the number of communities to which it belongs is calculated, so that the node becomes the community with the largest number of neighbors. As the community of this node and after this cycle for several times, the division of complex network has greater modularity. Experiments show that this initialization method can initialize the population well.
- (2) In the experimental part, the accuracy of PSO algorithm is compared with the other three algorithms. With the increase of the number of experiments, the accuracy decreases, and the accuracy of other data mining algorithms, artificial intelligence algorithms and decision tree algorithms is all reduced to lower values. However, PSO can always divide the syntactic complexity and semantic coherence of academic English writing well. Even when the number of experiments increases, when the number of experiments reaches 50, the PSO can still reach 48%, which shows that PSO has good clustering accuracy.

Chapter one introduces the background and significance of syntactic complexity and semantic coherence in English writing and then introduces the main work of this paper. The second chapter mainly introduces the literature review of syntactic complexity and semantic coherence in English writing. Chapter three describes the syntactic complexity and semantic coherence of PSO. In the fourth chapter, the

experiment is carried out, and the results are analyzed and discussed. The fifth chapter is a summary of the full text.

2. Related Work

2.1. Research Status. Jothi et al. studied the relationship between oral and written register characteristics and second language writing quality, and found that oral and written register characteristics are related to writing quality in many aspects [12]. Zhang et al. proposed that syntactic complexity follows the development sequence of multiple nested structures from restrictive clauses in the primary stage, unrestricted clauses and nested phrases in the intermediate stage, and to noun modifier clauses and multiple prepositional phrases as post modifiers in the advanced stage [13]. Jeon et al. pointed out that there is a problem of monotonous sentence patterns in students' compositions, and most of them are short sentences, while long sentences that conform to grammar are rare [14]. Chauhan et al. proposed that syntactic complexity indicators can be labeled manually or automatically, but manual labeling has two major defects. First, it is time consuming and laborious, and it is impossible to label large corpora. Second, subjective factors have great influence and are easy to make mistakes [15]. Frear et al. put forward the hypothesis that the higher the complexity of noun structure is not equal to the higher the quality of writing and verified this hypothesis by analyzing the use of interlanguage phrases in learners' and native speakers' doctoral theses [16]. Biber et al. put forward an empirical analysis of the problems existing in the English writing of junior college students from the perspective of syntactic characteristics. It is found that simple sentences are most used in the composition of high-level groups and low-level groups, complex sentences are not used much, and the sentence expression is relatively simple, while the sentence expression of low-level writers is more simple and poor, with little change in sentence patterns and single expression forms. It is an important factor affecting the quality of writing [17]. Joo et al. pointed out that most syntactic complexity indicators, especially language length and juxtaposition dimension indicators, can clearly distinguish syntactic complexity at different language levels. However, there are two problems worthy of attention. First, the scope of some indicators is too general. For example, the measurement of clause structure does not subdivide the specific indicators of spoken and written language. Second, the greater the value of some syntactic complexity indicators, the worse the writing quality may be predicted [18]. Andersen et al. proposed that the composition contribution generally found that the syntactic complexity in writing increases with the extension of learning time and the improvement of language level, but there is no final conclusion on the measurement dimensions and methods of syntactic complexity corresponding to specific language level, and whether the stronger syntactic complexity is equivalent to the higher writing quality or language level [6]. Leikin et al. proposed the change of syntactic complexity of English learners' compositions and found that the length index increased the fastest in grades 1-2 and then decreased first and then

increased, but the increase and decrease range was small. The density index reaches the peak in grade 2, but the range of change before and after is very small, and there is no obvious development trend [19]. Knudson proposed that the change of syntactic complexity over a period of time is in contrast to the differences in other aspects. Among different proficiency groups, most of them are interested in finding syntactic structure and are sensitive to different proficiency levels [20].

2.2. The Research Status of This Method. Based on PSO, this paper studies the syntactic complexity and semantic coherence of academic English writing, is interested in using the syntactic complexity of academic English writing as an index, and evaluates the impact of teaching intervention on grammar and writing ability, such as teaching plan, writing task, writing plan, task type and type, and so on. Under the PSO algorithm, syntactic complexity is defined as "the ability to compress more and more ideas or information blocks into less content". "Later studies have shown that this definition is incomplete because it involves only a large amount of information. Therefore, they incorporate changes in sentence types into the definition of syntactic complexity. Teachers can clearly understand students' progress and evaluate them based on PSO algorithm. After a period of teaching, students' changes in syntactic complexity can be invented. Based on these findings, they can adjust and improve the syllabus and design the most effective teaching methods Good teaching design to improve students' writing ability and language proficiency. In the teaching of academic English writing based on PSO algorithm, students should be provided with enough writing training opportunities to strengthen the syntactic complexity of learners' writing. Second, we should emphasize which subordinate structures have the characteristics of written language, such as subordinate connectives, relative clauses, nonrestrictive adverbial clauses and so on. Finally, use specific language examples to remind students not to abuse compound noun structure.

3. English Syntactic Complexity and Semantic Coherence of PSO

3.1. Particle Swarm Optimization and Its Principle. Once PSO was proposed, it immediately attracted extensive attention of scholars in the fields of evolutionary computing, computer science and management science, and achieved a large number of research results. At present, PSO is an effective optimization tool for nonlinear continuous optimization problems, combinatorial problems, and mixed integer nonlinear optimization problems [21]. PSO algorithm has the advantages of fast search speed, high efficiency, and simple algorithm, but it is also easy to fall into local optimization and premature phenomenon. Therefore, the combination of other intelligent optimization algorithms and PSO algorithm to make the two algorithms complement each other, so as to avoid the PSO algorithm falling into local optimization is the research hotspot of the majority of scholars. Different from the genetic algorithm based on

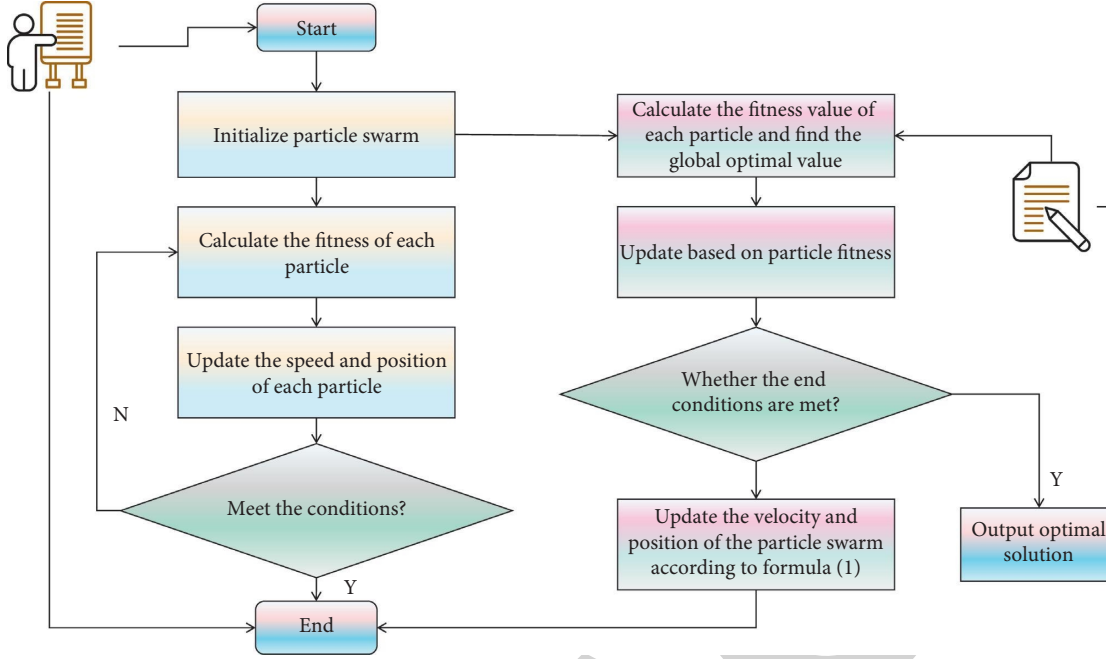


FIGURE 1: Flow chart of PSO algorithm.

Darwin's evolutionary thought of "survival of the fittest, survival of the fittest", PSO algorithm is to find the optimal solution through the cooperation between individuals. "At least in theory, a member of a biological group can benefit from the experience and discoveries accumulated by all other members of the group in the process of looking for food in the past [22]. This paragraph means that information sharing in biological groups will produce evolutionary advantages, which is the basic idea of PSO algorithm.

Imagine this scenario: a flock of birds are randomly searching for food. There is only one piece of food in this area. All birds do not know where the food is, but they know how far away they are from the food. This paper defines a quantitative index to quantify the population characteristics in the evolution process of PSO algorithm, record the historical quantitative data in real time, form a large number of time series, and provide input data for the function complexity classification model [23]. Similar to other algorithms, PSO algorithm can be used to solve most function optimization problems. Generally, these functions are very complex, mainly characterized by large scale, high dimension, nonlinearity, nonconvexity and nondifferentiability, and there are a large number of local optimal solutions. On the basis of ensuring the efficiency of the improvement strategy, the improvement strategy should be as simple and practical as possible. In addition, complex optimization strategies are not convenient for data analysis and summary. Simple optimization strategies are adopted to accelerate the program debugging process, improve the controllability of population characteristics, and make the population evolve towards the ideal evolution trend as much as possible [24]. PSO searches for the optimal solution in the feasible solution space by updating the position value through velocity. First, the particles in the population are initialized randomly, and

the optimal solution in the population is found by iteration. It represents the self-learning ability of the particle itself, even if the particle is close to the best position it has experienced. The third part represents the social cognitive ability, which makes the particles close to the global optimal position in the population, representing the ability of mutual cooperation between particles. The flow chart of PSO algorithm is shown in Figure 1.

In the whole search process of PSO, the c_1 value is often set to be larger at the initial stage, so that the particles learn from the individual extremum in many ways and learn from the social extremum less, thus expanding the search range and avoiding falling into the local optimum. In the later stage, c_2 value is often set to be larger, which makes the particles approach the social optimal value and increases the local search ability. The original PSO (PSO) algorithm has attracted the attention of scholars since it was put forward, and it has been applied in various fields. Update the velocity equation as follows:

$$V_{ij}(t+1) = \omega V_{ij}(t), \quad (1)$$

where ω is the inertia weight, the larger the value of ω , the stronger the global search ability of the algorithm, and the smaller the ω , the stronger the local search ability of the algorithm.

In the early stage, ω should be set to a large value, while ω should be set to a small value in the later stage. In this paper, a method of linearly decreasing inertia weight is proposed, and its formula is

$$\omega = \omega_{\max} - n * \frac{\omega_{\max} - \omega_{\min}}{n_{\max}}, \quad (2)$$

where ω_{\max} and ω_{\min} represent the maximum inertia weight and the minimum inertia weight, respectively, n is the

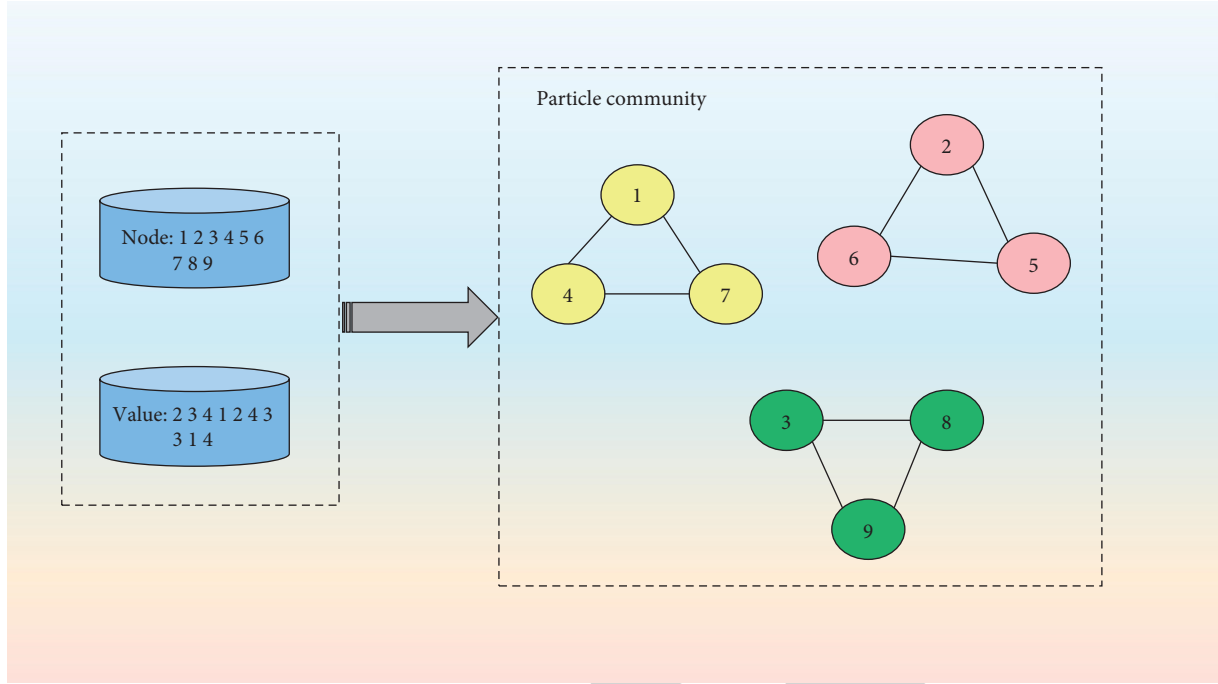


FIGURE 2: Schematic diagram of particle coding.

current iteration number, and n_{\max} is the maximum iteration number. The values of w_{\max} and w_{\min} are generally 0.9 and 0.4, respectively, and the value of inertia weight will gradually decrease with the increase of iteration times.

The best position in the population is represented by index number g , that is. The velocity and position formula of particles in each generation are as follows:

$$v_{id}(t+1) = v_{id}(t) + c_1 \text{rand}. \quad (3)$$

In which: $i = 1, 2, \dots, m$; $d = 1, 2, \dots, n$; rand is a random number that obeys the distribution.

Taking the adaptive parameters of time series as the main improvement strategy, the algorithm has obvious improvement effect, low program complexity, easy implementation, and quick implementation. Evolutionary strategy is

$$\begin{aligned} v_i^{k+1} &= w^k \cdot v_i^k + c_1^k \cdot r_1, \\ x_i^k &= x_i^k + v_i^{k+1}, \\ w^k &= (w_{\max} - w_{\min}) \cdot (\text{MaxIter} - k), \\ c_1^k &= (c_{1m} - c_{1n}), \\ c_2^k &= (c_{2m} - c_{2n}), \end{aligned} \quad (4)$$

where w_{\max} and w_{\min} are 0.9 and 0.5, respectively; c_{1m} and c_{1n} were 0.5 and 2.5, respectively; c_{2m} and c_{2n} were 2.5 and 0.5, respectively.

Based on the population evolution characteristic data of PSO, the given functions are classified according to their spatial complexity. The establishment of function complexity classification will help to qualitatively analyze the functions with unknown complexity characteristics and

propose targeted optimization strategies based on the results of qualitative analysis, so as to further strengthen the optimization performance for a given function. In this paper, the idea of tag propagation is used to initialize the population. First, each particle in the network is set into a different community, and then iteration is carried out. For each particle, the community to which all its neighbors belong is recorded, and the number of communities to which it belongs is calculated, so that the node becomes the community with the largest number of neighbors as the community of this node. After this cycle for several times, the division of complex network has greater modularity. Experiments show that this initialization method can initialize the population well. In PSO, each particle in the population represents a solution to the optimization problem. Combining with the specific problems found in complex network communities, this paper proposes a particle coding method, and the schematic diagram of particle coding is shown in Figure 2.

According to the coding characteristics of PSO and inspired by binary PSO algorithm, this paper designs a new particle update algorithm to update each individual in the population. The value formula is as follows:

$$V_{ij}^{(t+1)} = \omega V_{ij}^t + c_1 r_1. \quad (5)$$

It is proved that taking c_1, c_2 as 1.494 can make the algorithm converge effectively. Set $y_i = (p_{\text{best}_i}^t > x_i^t)$ rule

$$\text{if}(p_{\text{best}_i}^t > x_i^t) y_i = 1. \quad (6)$$

Then, the value of $V_{ij}^{(t+1)}$ is brought into the function, the obtained value is calculated, and then the value is compared with the number between 0 and 1 randomly generated by the computer, and the value of V_{ij}^{t+1} is obtained.

$$\begin{aligned} &\text{if}(\text{rand}() < S(V_{ij}^{(t+1)})) \text{ then,} \\ &\quad \text{else } V_{ij}^{t+1} = 0. \end{aligned} \quad (7)$$

In this paper, a local iterative search updating method is designed, and the particles in the population will be updated according to V . The concrete steps are as follows: first, the value of V_{ij} is judged; if $V_{ij} = 1$ is found, the value of this node in the particle is iteratively changed into the values of all its neighboring nodes in turn, and the modularity of the particle after updating this node is calculated, respectively; if modularity is greater than that of the particle in the original population, the particle in the original population is replaced with the updated particle; otherwise, no replacement is carried out.

3.2. An Empirical Study of Syntactic Complexity and Semantic Coherence in Writing. Because the syntactic complexity and semantic coherence of writing have been tested in writing, the research on the relationship between syntactic complexity and semantic coherence summarizes the proficiency of writing or language. There is no strong and direct relationship between syntactic complexity and writing quality, but this does not mean that they are not related. Syntactic complexity is an important factor affecting writing. The study of syntactic complexity can bring some enlightenment to writing teaching. For diversity and syntactic structure in language output, diversity refers to the variation from complexity to shooting range sentence patterns, that is, the flexible and appropriate use of various sentence patterns; complexity refers to the complexity of sentence structure, that is, clauses, unrestricted verb phrases, compound verb phrases, compound verb phrases, noun phrases, and nominalized sentences. As the teaching and research of second language writing, the complexity of the relationship between syntax and language, the language level of second language learners, the process of language development, and the quality of writing have also become the focus of many second language studies. The objective syntactic complexity measurement is not significantly correlated with the subjective manual score, the syntactic complexity does not follow the “three-stage linear” development law, and different syntactic complexity measurement indicators are suitable for the evaluation of second language writing at different language levels.

With the passage of time, people put forward various methods to measure syntactic complexity and semantic coherence. Before expounding these measures in detail, the author will first define some unit and structure complexity measures used in syntactic analysis. The quantitative objects of unit length, unit density, and occurrence frequency of syntactic complexity are one of various sentence patterns. Unit length refers to the average number of words in the output unit, and the common ones are T unit length and clause length. T -unit refers to “the smallest unit that contains the main clause, all clauses and non-clause structures.” Various studies were reviewed: one of them was the intervention to increase the mortality rate, which studied the

syntactic complexity and semantic coherence and its influence on the writing quality. The other was the research to examine the syntactic complexity of relations and the writing quality. Conclusion unit length and clause length seem to be a good predictor of writing quality, which may be due to other factors increasing T unit and clause length. Syntax complexity covers many aspects, including language output length, coordinate structure, subordinate structure, and nominalization.

These features are indicators to predict the development of English learners’ writing level. At present, more than 40 syntactic complexity measurement indicators have been used to describe the characteristics of these syntactic complexity. In addition, there is a significant relationship between syntactic complexity and writing quality, or each index of syntactic complexity can reflect writing quality to a certain extent. In studies using large amounts of data, it shows a linear relationship with proficiency. Other successful grammatical complexity measures also show that passive sentences, articles, relative clauses and compound nouns may be important structures relative to the level of development. Unit length and clause density can reflect the syntactic complexity and semantic coherence of students’ compositions. However, there are some syntactic features, such as adjective phrases, adverb phrases, and noun verb phrases. The use of these syntactic features will not only necessarily increase the unit length and clause density but also improve the degree of syntactic complexity. The use of subordinate structure of intermediate and advanced English learners is less than that of native speakers, but the use of compound nouns is close to or even more than that of native speakers. This finding is a challenge to the development law of “three paragraph” syntactic complexity. At the same time, it also needs to rethink the relationship between syntactic complexity and the writing quality of semantic coherence.

4. Results Analysis and Discussion

After the corpus collection, all Chinese students’ compositions. The evaluation and grading were conducted by three university writing professional raters. Therefore, it is confirmed that there is a strong correlation between grades x , y , Z and the average score, that is, the average score of raters x , y , and Z . Therefore, the final score of each article is composed of the average of the three scores given by three raters, that is, the average score. Correlation analysis of all writing scores. Check the relevance of all raters, as shown in Table 1.

In order to find out the differences of syntactic complexity and latent semantics between different proficiency levels, the author divided these 175 English compositions into two groups: according to the average scores of those English compositions, the first 23% were classified as high-scoring compositions, while the lowest 24% were classified as low-scoring compositions. In addition, in order to avoid misunderstanding of data by automatic software, formatting and spelling errors are eliminated.

This experiment compares the PSO algorithm with the accuracy of data mining algorithm, artificial intelligence algorithm, and decision tree algorithm on the syntactic

TABLE 1: Correlation between grades x , y and Z and average score.

| | Class X | Class Y | Class Z | Average |
|---------|---------|---------|---------|---------|
| Class X | | 0.342 | 0.457 | 0.697** |
| Class Y | 0.342 | | 0.307 | 0.633** |
| Class Z | 0.457 | 0.307 | | 0.603** |
| Average | 0.695** | 0.633** | 0.603** | |

**The correlation is significant at 0.01 level.

complexity and semantic coherence of academic English writing. The experimental results are shown in Figure 3.

It can be seen from Figure 3 that the accuracy decreases with the increase of the number of experiments. Compared with other data mining algorithms, artificial intelligence algorithms, and decision tree algorithms, the accuracy decreases to a lower value. However, PSO algorithm can always better divide the syntactic complexity and semantic coherence of academic English writing. Even when the number of experiments increases and the number of experiments reaches 50, the PSO algorithm can still reach 48%. It can be seen that PSO algorithm has better clustering accuracy.

In this experiment, PSO algorithm, other data mining algorithms, artificial intelligence algorithm, and decision tree algorithm are used to divide the syntactic complexity and semantic coherence of academic English writing in its four real networks, and an error rate comparison is carried out. The experimental results are shown in Figure 4.

As can be seen from Figure 4, when the number of experiments is 40, the error rate of data mining algorithm is 58.3%, that of artificial intelligence algorithm is 53.4%, that of decision tree algorithm is 57.1%, and that of PSO algorithm is 47.1%. The modularity calculated by PSO algorithm can reach the best value among the other three algorithms. Therefore, PSO algorithm has better performance on syntactic complexity and semantic coherence of academic English writing.

The highlight of PSO is that it puts forward the idea of complexity and semantic coherence, which is beneficial to mining high-quality community structure even when the network structure is very fuzzy. The detail levels of different proficiency levels are summarized, as shown in Table 2.

As can be seen from Table 2, the writing data of all Chinese students and American students are saved in handwritten forms. It is necessary to input computer files to facilitate the data process. When inputting compositions with the keyboard, keep the original form of each article, including capital letters, punctuation, and even spelling and grammatical errors. In this case, the data should reflect the real quality of students' writing. After the above efforts, proofreading has been carried out to ensure keyboard input. Details of the data used in this study are shown in Table 3.

As can be seen from Table 3, the system can calculate 14 different syntactic complexity indexes by taking one sample as input for automatic measurement of syntactic complexity, which has been explored or proposed in the second language development literature. This system has achieved high reliability when processing data from written English corpus. This automatic corpus tool is used to calculate a set of syntactic complexity measures in a large number of large-

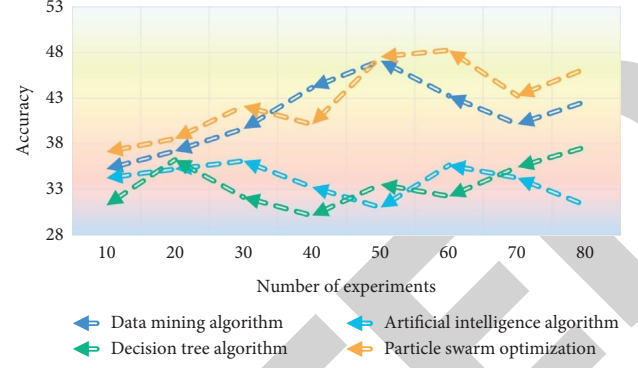


FIGURE 3: Comparison of accuracy between PSO algorithm and other three algorithms.

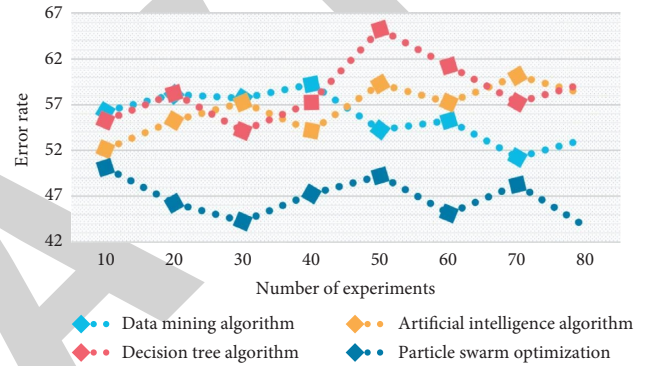


FIGURE 4: Comparison of error rates between PSO algorithm and other three algorithms.

TABLE 2: Summary of details of different proficiency levels.

| Group | Article count | Score range |
|---------------|---------------|-------------|
| High grouping | 44 | >87.751 |
| Low grouping | 43 | <83.624 |

TABLE 3: Data summary.

| Group | Ns | NNS | NNS-high | NNS-low |
|------------------------|--------|--------|----------|---------|
| Number of writing | 51 | 203 | 105 | 102 |
| Average writing length | 151.73 | 133.21 | 147.32 | 119.13 |
| Total words | 7,586 | 26,643 | 14,731 | 11,913 |

scale corpus data, which eliminates the intensity of manual annotation and calculation.

This experiment explores the syntactic complexity and semantic coherence of academic English writing and makes experiments on the development patterns of simple sentences, complex sentences, and complex sentences. The experimental results are shown in Figure 5.

As can be seen from Figure 5, simple sentences account for the largest proportion in the total number, and the sentence types used in students' compositions are followed by compound sentences. In contrast, the proportion of compound sentences and compound sentences is quite large compared with the first two. This result is consistent with the research results, which shows that the overuse of simple

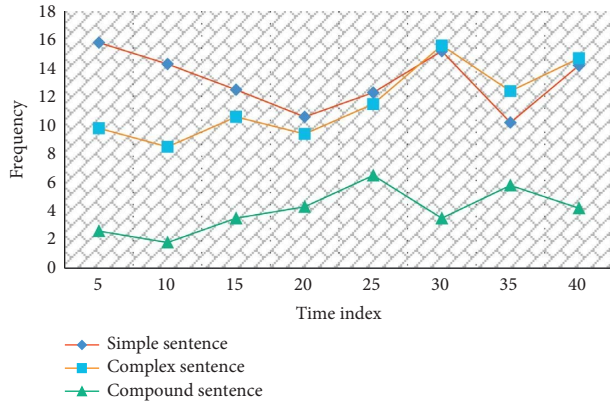


FIGURE 5: Development trend of three independent sentences.

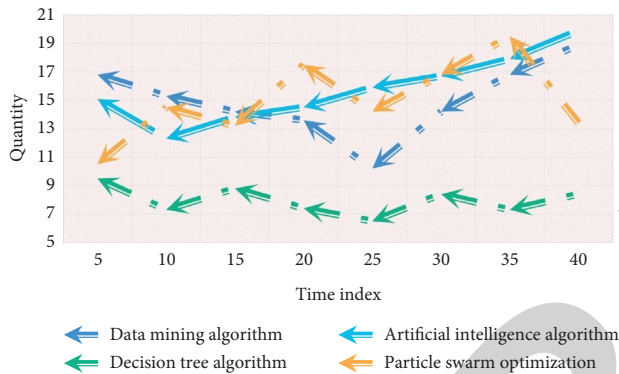


FIGURE 6: Trends of complexity and semantic coherence under different algorithms.

sentences is a common reality in China. In order to show more clearly how to use the three basic sentence types.

In this experiment, PSO algorithm, data mining algorithm, artificial intelligence algorithm, and decision tree algorithm are used to study the changing trend of syntactic complexity and semantic coherence of academic English writing. The experimental results are shown in Figure 6.

As can be seen from Figure 6, all three algorithms show an upward trend, and the decision tree algorithm hardly rises. The decision tree algorithm written for the first time is 9.2143, the maximum value of PSO algorithm is 19.2148, and the minimum value is 11.1254. Therefore, great changes have taken place from the minimum value to the maximum value. The research results of the change trend of data mining algorithm and artificial intelligence algorithm are the same, showing obvious growth trend, and both of them have almost increased greatly.

In this experiment, the correlation between the indexes of syntactic complexity and semantic coherence and writing achievement is studied, and the data mining algorithm, artificial intelligence algorithm, decision tree algorithm, and PSO algorithm are used to make experiments. The experimental results are shown in Figure 7.

It can be seen from Figure 7 that the number of phrases is related to the writing performance. When the number of experiments reaches 25, the significant value of data mining

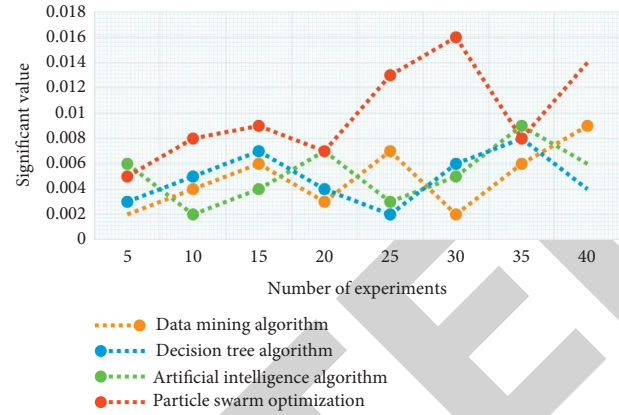


FIGURE 7: Correlation between sentence complexity and semantic coherence and writing performance.

algorithm for syntactic complexity and semantic coherence is 0.008, the significant value of artificial intelligence algorithm is 0.003, the significant value of decision tree algorithm is 0.002, and the significant value of PSO algorithm is 0.013. It can be seen that PSO algorithm is the best.

5. Conclusions

This paper studies the syntactic complexity and semantic coherence of academic English writing based on PSO algorithm. The number of phrases is related to the writing performance. When the number of experiments reaches 25, the significant value of data mining algorithm in syntactic complexity and semantic coherence is 0.008, the significant value of artificial intelligence algorithm is 0.003, the significant value of decision tree algorithm is 0.002, and the significant value of PSO algorithm is 0.013. It can be seen that PSO algorithm is the best. Syntactic length and phrase number are related to writing quality, while syntactic density is not related to writing quality; there are significant differences in syntactic length and the number of phrases between the groups with high and low writing scores; students use more clauses in writing; syntactic complexity and semantic coherence can predict writing performance; and the number of phrases can significantly predict writing performance. PSO has certain enlightenment and guiding significance for English writing teaching. Through the training of writing strategies such as sentence pattern conversion, the use of complex noun phrases and verb diversity expression will help to improve the students' syntactic complexity and composition quality. The syntactic complexity and semantic coherence under PSO algorithm have a certain impact on the quality of writing, especially the length index and the number of phrases. Teachers should encourage students to use various syntactic structures and increase the diversity of composition structures in writing teaching.

Data Availability

Data are available on request from the corresponding author.

Retraction

Retracted: SURF Algorithm-Based Data Aggregation Method and Digital Sharing Economy

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Chen, M. Zhang, B. Hyng, and R. Wang, "SURF Algorithm-Based Data Aggregation Method and Digital Sharing Economy," *Mobile Information Systems*, vol. 2022, Article ID 1513129, 10 pages, 2022.

Research Article

SURF Algorithm-Based Data Aggregation Method and Digital Sharing Economy

Yeqing Chen ^{1,2}, Mengze Zhang,² Baeki Hyng,² and Rui Wang¹

¹Ningbo University of Finance and Economics, College of International Economics and Trade, Ningbo 315175, Zhejiang, China

²Department of Economics, Sejong University, Seoul 05006, Republic of Korea

Correspondence should be addressed to Yeqing Chen; chenyeqing@nbufe.edu.cn

Received 26 May 2022; Revised 16 June 2022; Accepted 21 June 2022; Published 4 July 2022

Academic Editor: Amit Gupta

Copyright © 2022 Yeqing Chen 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.

Data aggregation technique removes redundant message in original data, reduces the amount of data transmission, reduces network communication overhead, improves message acquisition accuracy and collection efficiency, and prolongs the effective working time of the network. It is an energy-saving technique widely used in wireless sensor networks, one of the techniques. However, with the continuous operation in the wireless sensor network, the data aggregation technique saves the energy cost of the network, but also brings new security risks to the network. Therefore, how to ensure the confidentiality and integrity of data in the process of aggregation, calculation, storage, and forwarding is the core link of wireless sensor network security research. This paper uses SURF algorithm to study this question. The algorithm in this paper not only has good robustness to the data, but also introduces data aggregation and box filter in the calculation, so that the registration time can be better improved. After the research in this paper, the accuracy of the algorithm in this paper is 19% better than the traditional algorithm. At the same time, the accuracy of the aggregated data increases over time as the channel congestion decreases in the traditional process.

1. Introduction

Nowadays, more and more sharing means can be seen everywhere in life, such as Didi, mobike, and so on. This change is mainly to change the ownership of intellectual property rights into the right to share the use. Therefore, many idle resources can be used instead of being wasted. Therefore, in this case, people's needs have changed [1]. At present, digital aggregation and digital economy permeate all aspects of human production and life, and continuous industrial integration and innovation have promoted the emergence of various new formats and business models of the sharing economy, driven economic transformation, and upgrading and promoted the smooth progress of supply-side structural reform, which has brought about earth-shaking changes in the future business operation mode and people's lives [2]. In addition, people's high utilization rate of the network makes the network the most important message medium in modern society, and the digitalization of message in the network has also aroused great concern [3]. People cannot get rid of the dividends brought by

the digital economy. Whether it is daily work and study or personal life, high-tech digital techniques such as cloud and big data have a great influence on us [4]. Among them, data aggregation means and digital sharing economy affect our lives. Compared with the traditional economic model, data aggregation has a higher efficiency of resource optimal allocation, which enables it to achieve transcendental progress in many domains. Therefore, workers should deeply analyze the improvement trend of digital economy and take effective countermeasures to give full play to the effectiveness of digital economy [5]. Data aggregation has been closely linked with people's daily life and work, and cloud computing and big data analysis technique have become the driving force of digital economy improvement [6]. However, in the era of sharing, the improvement of data aggregation is still accompanied by many obstacles. Only by further analyzing the improvement trend of digital economy, can we put forward targeted improvement measures to promote the improvement of digital economy in the sharing era [7]. In the new stage of China's improvement, the digital economy is based on the Internet,

with digital knowledge and message as the key factors of production and digital technique as the core driving force to penetrate all walks of life, realize the linkage of various industries, and promote the optimization and upgrading of economic structure, which brings a new dawn for China's economic improvement. It can be seen that digital economy, as a new economic form, will become a new engine to promote the future growth of China's economy. Therefore, it is of great practical significance to deeply explore the growth effect of digital economy on economic improvement for finding a new breakthrough in economic growth [8]. The rapid improvement of digital economy has promoted industrial transformation and upgrading and brought changes to the production mode and personal consumption pattern of enterprises, and the improvement of traditional industries has also been digitalized. It can be seen that the impact of developing digital economy on China's economy is becoming more and more important. A new round of scientific and technological revolution is bound to bring a new round of industrial transformation, and digital economy is the inevitable outcome of the new round of scientific and technological revolution. Digital economy will be based on the cross-integration of multiple techniques, improve the efficiency of economic improvement, change the existing economic growth mode, promote the upgrading and integration of industries, and then promote the path transformation of China's economic growth and achieve high-quality improvement [9]. Digital economy is a new economic form. The improvement of digital economy is closely related to ICT technique, and the digital economy is accelerating its penetration and changing the operation mode of other industries. To sum up, most scholars believe that digital economy is a new and staged economic form based on data, knowledge, and message, and it is subverting the traditional market economic structure and resource allocation mode [10]. A comprehensive understanding of the improvement status of digital economy and its specific impact on economic improvement will help inject new impetus into China's economic improvement, find new supporting points to promote high-quality economic improvement, and realize sustainable economic improvement. Based on the Internet, digital economy, as an invisible economic form, drives the digital industrialization, digitalization of industries, and the transformation of production and consumption in the whole society and then drives economic growth [11]. The existing research focuses on the direct impact of digital economy on economic growth and its specific mechanism. The improvement of digital economy has positive promoting effect and double threshold effect on economic growth. With the continuous improvement of digital economy, the promoting effect on economic growth gradually increases. Digital economy can significantly promote high-quality economic improvement, but there are significant differences in the effects of digital economy on high-quality economy among different regions.

The innovations of this paper are as follows:

- (1) Data aggregation technique is used. Secure data aggregation (SDA) can not only solve the question of insufficient resources of WSNs nodes, but also

provide security protection for private data. The benefits of using data aggregation technique in wireless sensor networks are obvious.

analyzed the improvement trend of digital economy in the sharing era, got a good understanding of the environment, and let us know why we should study this topic. The integration of digital economy and sharing economy has promoted the improvement of sharing era. At the same time, the sharing era also puts forward new requirements for the improvement of digital economy, which makes it different from the traditional improvement mode and presents a new improvement trend. In the sharing era, the sharing economy will move towards the digital highway and achieve rapid improvement by integrating the digital economy.

- (3) SURF algorithm is adopted. SURF algorithm is not only robust to data, but also introduces data aggregation and box filter in the calculation, which improves the registration time. Data aggregation is the summation of all data, which can realize fast box convolution filtering.

This paper is divided into five parts:

The first part is the background and summary. The second part is the related research and the introduction of this paper. The third part is some related theories, so that readers will not be confused. The fourth part is the algorithm and simulation research, including the experimental content. The fifth part is the summary.

2. Related Work

Sultana suggested that the current improvement level of digital technique is changing with each passing day under the background of economic globalization. Message technique in various countries is infiltrating and merging with all walks of life, and it has continuously injected new vitality into the global economy, which has become a powerful kinetic energy for the new generation to promote economic growth. In this paper, SURF algorithm is used to study the data aggregation means and digital sharing economy. In the practical application of wireless sensor networks, the aggregation process of collected data is directly related to the physical topology, which determines the aggregation node with the best physical location and the transmission path of aggregated data. The research of this paper is of great significance [12]. Cho suggested that the digital economy is mainly embodied in the following three aspects: firstly, the infrastructure represented by the communication network, secondly, an e-commerce, that is, online transactions that are conducted by digitalization, and secondly, the digitalization of economic improvement mode, such as the digitalization of transaction message [13]. It is suggested that the difference between digital economy and traditional economy is that the transaction form between goods and services is carried out in a digital way, and the product sales are different from the traditional marketing channels. Compared with the traditional sales means, the digital economy period

sells products directly online, which has a relatively low cost, and provides consumers with more diversified choices in terms of price and function [14]. Ren et al. suggested the contribution rate of the computer industry to the economy. It is found that the effect of computer expenditure on economic growth is related to time. In the short term (1-2 years), the contribution of computers to total factor productivity is almost zero. In the long term (more than 5 years), the contribution of computer investment to total factor productivity is more than five times that of investment [15]. Sánchez suggested that, in the improvement of digital economy, digital economy is a brand-new way to promote the circulation of commodities and the improvement of service industry. Its trading mode is online, and it flows in the Internet with digital message as the medium. Therefore, its scope includes not only e-commerce, but also the message technique industry developed through e-commerce. The paper also pointed out that it can promote the improvement of digital economy from three aspects: improving innovation ability, carrying out effective macrocontrol, and guiding and perfecting the capital market system [16]. Liu et al. suggested that the rapid improvement of hardware makes the price of message products drop, which has substitution effect on other products, and the cost reduction speeds up the popularization of Internet products. According to Metcalfe's law and Moore's law, Internet technique further promotes economic growth [17]. Peris-Ortiz suggested that digital economy is the inevitable trend of economic improvement nowadays. It is a brand-new economic form, which is developed based on knowledge. The means are digital technique (computer and Internet), which involves all domains of production (manufacturing, management, circulation) and is embodied in digital form. Digital economy itself has the characteristics of digitalization, virtualization, networking, and modularization [18]. Chen suggested to investigate the improvement of digital infrastructure in OECD countries from 1970 to 1990 and found that it promoted the GDP of the country [19]. Popkova and Sergi suggested that the foundation of digital economy is message and communication technique, and all the production and management involved in it are realized through electronization. The interconnection between suppliers and consumers is generated through the Internet. With the help of digital network and communication technique, it provides a global communication platform for people all over the world to communicate and cooperate accordingly [20]. Huo et al. suggested using data from 22 OECD countries as samples and analyzed that digital infrastructure has a positive effect on the ratio of fixed capital stock to gross national product [21]. Bondarenko and Yudina suggested that the digital economy refers to the continuous application of digital technique and digital transactions of related products. It is a new type of economy with virtual characteristics, which takes place in the digital space. The emergence of digital economy has greatly changed the traditional relationship between individuals, enterprises, and society [22].

In this paper, SURF algorithm is used to study the data aggregation means and digital sharing economy. In the practical application of wireless sensor networks, the

aggregation process of collected data is directly related to the physical topology, which determines the aggregation node with the best physical location and the transmission path of aggregated data. The research of this paper is of great significance.

3. Related Theories

3.1. Data Aggregation. Wireless sensor networks (WSNs) are an effective means of data acquisition and transmission in the Internet of Things environment. It is a multihop self-organizing network system composed of hundreds of miniature electronic sensor devices. Data aggregation refers to the data processing process in which some nodes (or only one node) collect the perceived data of other nodes, so as to reduce the transmission of original data, thereby reducing the communication bandwidth occupancy rate and saving energy resources. Compared with the traditional network, wireless sensor network has the following outstanding characteristics: sensor network is a network system that integrates monitoring, control, and wireless communication, with a large number of nodes and dense distribution. Secure data aggregation (SDA) can not only solve the problem of insufficient resources of WSNs nodes, but also provide security protection for private data. Its main idea includes two parts: aggregating multiple pieces of message from multiple sensor nodes into one piece of message. The security of data is ensured by encryption algorithm. Data aggregation is an important data processing means in wireless sensor networks. It is a process of collecting data from sensor nodes in the network, summarizing it to the upper aggregation node or aggregator for data analysis and sorting, that is, restoring the real situation in the network. The data aggregation routing algorithm division is shown in Figure 1.

Due to the limited resources of sensor nodes, the security of the data uploaded by them cannot be guaranteed, so data aggregation needs to be carried out at the aggregation node of the upper layer. The benefits of using data aggregation technique in wireless sensor networks are obvious. However, because wireless sensor networks are usually used in sensitive domains such as business, environment, and military affairs, data aggregation technique must meet the security requirements of wireless sensor networks. At the same time, the continuous operation of data aggregation will not only improve bandwidth and energy efficiency, but also have some unique negative effects on network security. Therefore, data aggregation technology must improve the energy efficiency of the network and, at the same time, ensure the security of the whole network data aggregation operation, not at the expense of security. The basic idea of secure data aggregation scheme based on perturbation is that nodes generate one or more random numbers (perturbation factors), and the original data and perturbation factors are fused by polynomial algebraic properties to hide sensitive data without changing some data characteristics. There is no obvious difference between the statistical message after the disturbance and that of the original data. As a data-centric network, the core work of wireless sensor network is to

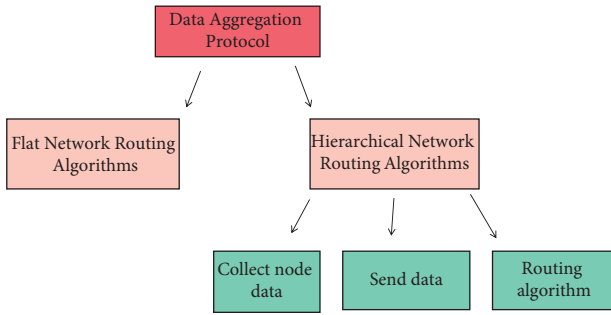


FIGURE 1: Data aggregation routing algorithm division.

cooperatively perceive, collect, and process the message of perceived objects in the network coverage area and report it to the network deployer, and security is the core foundation and fundamental guarantee of this work. There are security questions or unreliable aggregated data that will delay, mislead, or even destroy the normal work of the whole network. Because RF operation consumes more energy than CPU instruction, it is necessary to reduce communication overhead. The flowchart of data aggregation generation is shown in Figure 2.

Data aggregation can aggregate multiple pieces of data from multiple sensors into one piece of data at one sensor node. After aggregation, the forwarding amount of nodes in the whole WSNs will be greatly reduced, thus achieving the purposes of saving energy, prolonging the network life cycle, and reducing data redundancy. In the process of data acquisition, data is collected at the aggregation node (also called cluster head), and the merged data is transmitted to the base station. The retrieval means of database include data collection and secure access to the message of base station. Data aggregation protocols are divided into topology tree protocol and cluster protocol. In tree-based data aggregation, data flows from the sensor node (child node) to the top node (parent node), and the aggregation takes place on the parent node. Unsafe data aggregation can make the whole network's data collection work fall short, but it is aimless to study the security of sensor network without the core work of data aggregation. Therefore, the core task of the security mechanism of wireless sensor network is to ensure that all nodes collect data safely, realize the secure aggregation of data on appropriate nodes, and transmit these data to sink nodes safely. At present, the research on two key techniques of data aggregation and security in wireless sensor networks has been quite in-depth, but the research on the security of data aggregation technique, especially the security of data aggregation operation in application layer, is still few, which has important research significance.

3.2. Improvement Trend of Digital Economy in Sharing Era.

The number of Internet users in China has exceeded 900 million, and the Internet penetration rate is nearly 65%. China already has a huge group of Internet users, which constitutes the prosperous digital economy consumption market in China and lays a solid realistic foundation for the improvement of digital economy. The integration of digital

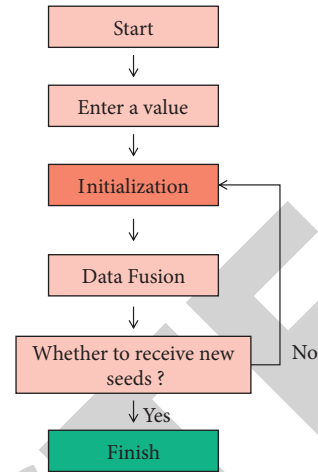


FIGURE 2: Flowchart of data aggregation generation.

economy and sharing economy has promoted the development of sharing era. At the same time, the sharing era also puts forward new requirements for the development of digital economy, which makes it different from the traditional development mode and presents a new development trend. In the sharing era, the sharing economy will move towards the digital highway and achieve rapid development by integrating the digital economy. At present, the market scale of the sharing economy is gradually increasing. With the participation of more people, wider sharing scope, and penetration of wider fields, the sharing economy will enter a period of all-round development and innovative development, which requires new kinetic energy to participate. Digital economy is the key power to effectively promote the stable improvement of the sharing era. In the sharing era, the sharing economy gradually integrates and infiltrates the digital economy and realizes digital improvement. In the market economy, corresponding to the new economic form of digital economy, the old economic form is industrial economy.

The industry has brought the “big bang of production” to the market, while the digital economy has brought the “big bang of trading.” Building a good digital business environment is also an important mission of the blockchain system. Through the intelligent contract mechanism, a digital connection is established between enterprises and consumers, and a sequential transaction record opening mechanism and self-discipline supervision constraint with limited sharing between enterprises and industries are formed, which can effectively avoid contract fraud and moral hazard caused by message asymmetry among enterprises. At present, digital technique has accelerated its penetration into various domains, promoted the economic and social evolution to a higher level, and provided a historic opportunity to break the global digital economy competition pattern. In the current society, the market scale of the sharing economy is constantly expanding, and the broad masses of the people are actively participating. The sharing economy will soon enter a new era of innovation and improvement, so it needs some new kinetic energy as support.

With the continuous development of society, cloud technology and big data have been integrated into all fields of society, providing a guarantee foundation for the development of digital economy and supporting the stable development of shared economic information and trading platform. With the rise and popularization of the Internet and the wide application of big data and cloud computing, the digital economy is booming. In order to achieve rapid development of the sharing economy in the future, it is necessary to increase information sharing, reduce transaction costs, improve transaction matching rate, and promote the transformation of the real economy to digitalization with the help of digital economy dominated by big data and cloud computing.

In the era of message, technique, and knowledge sharing, transactions and decisions can be made on the Internet. At the same time, after the transaction is completed, the docking between orders and warehousing logistics can also be directly realized by means of this interconnection and sharing mode; thus, the transaction activity has broken through the limitations of physical laying, has infinite extensibility and high efficiency, and has formed the trend of digital economy scale improvement of “big bang.” And this trend of the big explosion of transactions has also brought a lot of revenue to enterprises in various domains. Digital technique also provides more quality signals and supervision opportunities for both parties to the transaction, forcing enterprises to actively choose products and services with qualified quality. If this kind of credit chain is further expanded, a multilateral credit network around the core enterprises can be formed, and the online presentation of offline resources can be realized by virtue of the intelligent contract mechanism and the mapping traceability mechanism. Therefore, such a data sharing and resource transaction agreement that covers enterprises, industries, and consumers will also promote enterprises to gain larger-scale trust capital with lower transaction costs and bring the market economy to the fast lane of “business environment improvement-mass entrepreneurship-innovation-achievement sharing.” With the rapid improvement of digital economy and the country’s great emphasis on digital economy, the full integration of digital economy into the sharing era will surely drive the sharing economy to take on the wings of digitalization and move towards the road of high-speed digital improvement.

4. SURF Algorithm-Based Data Aggregation Means and Digital Sharing Economy

4.1. Data Aggregation Based on SURF Algorithm. Speeded-Up Robust Feature (SURF) is a fast and robust feature extraction registration algorithm based on Scale Invariant Feature Transfer ORM (SIFT) algorithm. SURF algorithm is put forward on the basis of SIFT algorithm, which is mainly improved to solve the question of high time complexity of SIFT algorithm. The steps of SURF algorithm are basically the same as those of SIFT algorithm, but the operation speed is increased by 3~5 times. SIFT algorithm is a feature registration algorithm, which was put forward in

1999 and improved in 2004 through the research of scale invariance, radiation invariance, and local invariance detection means. SURF algorithm mainly includes three parts: extracting feature points, constructing feature descriptors, and feature matching. Although SHIT algorithm has strong uniqueness for the local characteristics of data, it has certain robustness for data. However, SIFT algorithm has a large amount of data calculation and registration takes a long time. Because SIFT algorithm takes a long time, SURF algorithm was born. SURF’s detection of feature points probably includes the following points: constructing data aggregation, approximating Hessian matrix, constructing scale space, and accurately locating feature points. SURF algorithm not only is robust to data, but also introduces data aggregation and box filter in the calculation, which improves the registration time. Data aggregation is the summation of all data, which can realize fast box convolution filtering. Compared with other algorithms, SURF algorithm not only has better scaling, rotation, translation, and other characteristics, but also has a fast calculation speed, and the improvement of calculation speed largely depends on the establishment of data aggregation. Data aggregation is the data obtained by calculating the original data. Each data of the aggregated data is represented as the data sum of the original data from the original data to the data.

The value of the aggregate data $I_{\Sigma(x,y)}$ at a certain data (x, y) in the data is the sum of all data values from the original data $I(x, y)$ to the whole area of the data, and the expression is as follows:

$$I_{\Sigma(x,y)} = \sum_{i=0}^{i \leq x} \sum_{j=0}^{j \leq y} I(i, j). \quad (1)$$

$I(i, j)$ is the original data of data point (i, j) . After the data aggregation is established, if you want to calculate the sum of all the data in the data, you only need to calculate the data aggregation and simply add and subtract the original data.

The reason why the establishment of data aggregation can speed up the calculation is that after we traverse all the data in data aggregation, the sum of the data in any area of the original data can be completed by addition and subtraction, regardless of the data value of the rectangle. The larger the rectangle is, the more calculation time will be saved.

Let the signal metric and energy metric of node i be

$$\begin{aligned} H_0: x_i(t) &= n_i(t) \\ H_1: x_i(t) &= s_i(t) + n_i(t), \\ \xi_i &= \sum_{t=1}^M |x_i(t)|^2, \\ i &= 1, 2, \dots, N, \end{aligned} \quad (2)$$

where M obeys approximately Gaussian distribution. And assuming that the noise samples are independently and identically distributed in time and space (*i.i.d*), it can be proved that

$$\begin{aligned}
E\{\xi_i|H_0\} &= M\sigma_i^2 \\
E\{\xi_i|H_1\} &= M\sigma_i^2(1 + \varsigma_i) \\
D\{\xi_i|H_0\} &= 2M\sigma_i^4 \\
D\{\xi_i|H_1\} &= 2M\sigma_i^4(1 + 2\varsigma_i).
\end{aligned} \tag{3}$$

Among them, $\varsigma_i = \sum_{t=1}^M s_i^2(t)/M\sigma_i^2$. Furthermore, that statistical service of statistic ς_i obeys the following distribution:

$$\xi \sim \begin{cases} N(M\sigma_i^2, 2M\sigma_i^2), & H_0, \\ N(M\sigma_i^2(1 + \varsigma_i), 2M\sigma_i^2(1 + 2\varsigma_i)), & H_1. \end{cases} \tag{4}$$

Based on the energy estimation, the node i generates a binary random variable φ :

$$\begin{aligned}
\xi_i < \Lambda &\Rightarrow \varphi_i = 0 \Rightarrow H_0 \\
\xi_i \geq \Lambda &\Rightarrow \varphi_i = 1 \Rightarrow H_1.
\end{aligned} \tag{5}$$

Among them, the local detection threshold Λ is the same for N nodes. The local false alarm probability and local detection probability of node i are as follows:

$$\begin{aligned}
p_{fa}^i &= \Pr(\xi_i \geq \Lambda|H_0) = Q\left(\frac{\Lambda - E\{\xi_i|H_0\}}{\sqrt{D\{\xi_i|H_0\}}}\right) \\
p_d^i &= P_r(\xi_i \geq \Lambda|H_1) = Q\left(\frac{\Lambda - E\{\xi_i|H_1\}}{\sqrt{D\{\xi_i|H_1\}}}\right).
\end{aligned} \tag{6}$$

The extracted features of data have certain influence on data aggregation, and good features generally have repeatability, uniqueness, and strong robustness. SURF algorithm does not use pyramid but uses box filters with different sizes to process the original data. Because data aggregation is used, the calculation speed is the same no matter how the size of box filters changes. The construction principle of SURF algorithm's characteristic point response differential pyramid is the same as that of SIFT algorithm's aggregation differential pyramid, and the data of the first scale group can be directly obtained by interlaced deletion of rows and columns and downsampling.

Suppose the sender D of the message has a message $s \in \mathbb{Z}_q$ (q is a big prime number) to send. Take care of $p > s$, D during the sending process. $(t-1)$ elements a_i ($i = 1, 2, \dots, t-1$) will be selected in the finite domain to form $(t-1)$ -order multiple items:

$$f(x) = \sum_{i=1}^{t-1} a_i x^i \pmod{p}. \tag{7}$$

D : Add the message to be sent to the polynomial as a constant term, that is, $s = f(0) = a_0$. D : Generate an encrypted message for each forwarder s_r ($r = 1, 2, \dots, n$):

$$s_r = f(x_r) = \sum_{i=1}^{t-1} a_i x_r^i \pmod{p} \quad (r = 1, 2, \dots, n). \tag{8}$$

This message will be sent by D to the forwarder and then forwarded by the forwarder to the final receiver R .

R : As long as the encrypted message sent by any t forwarders is received, the original message can be recovered using the Lagrange interpolation formula:

$$s = f(0) = \sum_{i=1}^t f(x_i) \prod_{v=1, v \neq i}^t \frac{-x_v}{x_i - x_v} \pmod{p}. \tag{9}$$

If the number of encrypted messages received by R is less than t , the data cannot be recovered.

Data operators are used for scale analysis. In practical applications, data operators need to be discretized and modified. Due to the undersampling of data operators, spectrum aliasing will occur. When the variation rate is very low, a new structure will appear when the data is filtered in one dimension, and a new structure will also appear when the data is filtered in two dimensions.

4.2. Algorithm Simulation. A plurality of cooperative sensor nodes deployed in an area report the processed observation results to the aggregation node. Then, after receiving the contributions of all sensor nodes, the aggregation node adopts certain strategies to aggregate these contributions and make a global decision. However, the bandwidth and energy of the microdevices corresponding to these sensor nodes are limited. In addition, the geographical distribution of this system makes it vulnerable to different types of attacks. Considering these factors, it is a challenging task to make wireless sensor networks secure. In WSNs with cluster topology, the cluster head node needs to gather the information of the whole cluster and send it to the base station. Therefore, the cluster head node is the most important node in the cluster topology, and its security and accuracy are related to whether the data in the whole cluster can be fully utilized. In the wireless network security data aggregation technology, the purpose of privacy protection is to ensure that users' privacy data cannot be obtained by other users. Even if the transmitted data is intercepted and cracked, the attacker still cannot restore the sensitive data of the user. Like traditional networks, wireless sensor networks are also faced with many security threats. The local sensor node's decision-making process (i.e., local detection performance) itself will also be threatened by various security threats. The detection performance largely depends on the reliability of these sensor nodes in the network. As can be seen from Figures 3–5, the accuracy of the algorithm in this paper is higher than that of the traditional means. Moreover, as the number of slices increases, BX has more data slices for verifying message.

Only when the base station obtains the number of data not less than the threshold, can the original data be recovered, thus ensuring the security of the cluster head node; ISSA slices the aggregated data of cluster head nodes, and the sliced data can also realize homomorphic addition, thus reducing the traffic. The base station can verify the data through the received data. It randomly selects multiple groups of different data segments from data segments and

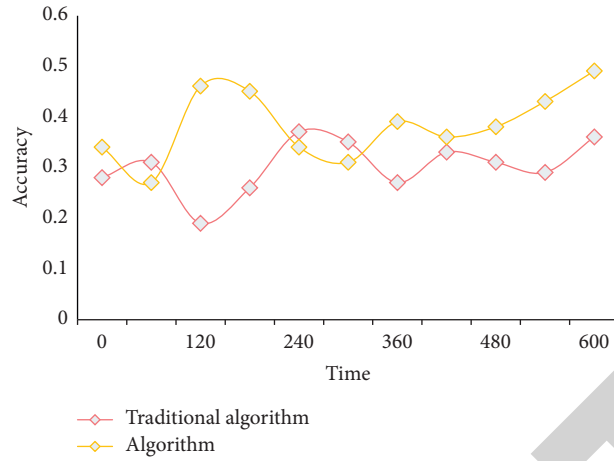


FIGURE 3: Comparison of graph node accuracy.

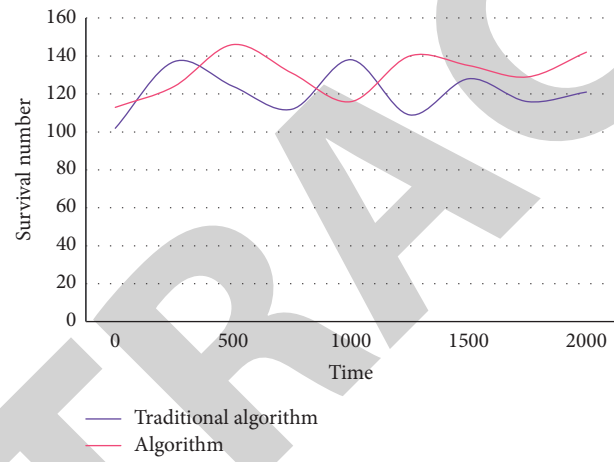


FIGURE 4: Node survival.

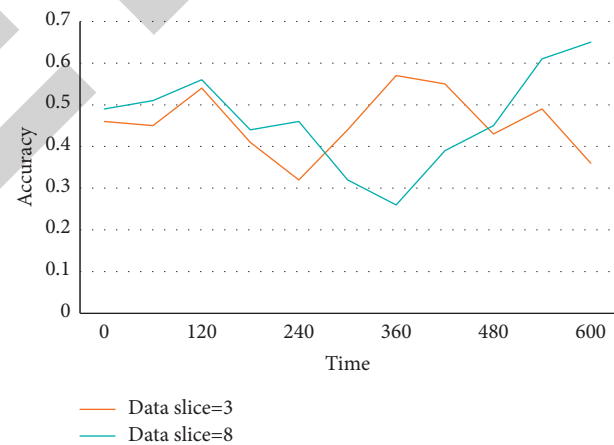


FIGURE 5: Accuracy of the algorithm in this paper under different data slices.

obtains multiple results through calculation, which can verify each other and improve the accuracy of cluster head node aggregation data. By aggregating the data received by

sensor nodes deployed in space, reliable aggregation node decisions can be made on the state of the phenomenon, but it is possible that one or more sensor nodes (destroyed by

TABLE 1: Operand comparison.

| | 0 | 60 | 120 | 180 | 240 | 300 | 360 | 420 | 480 | 540 | 600 |
|-----------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Traditional algorithm | 3.7 | 3.5 | 3.1 | 4.2 | 4.5 | 2.6 | 2.2 | 3.6 | 3.1 | 4.0 | 4.2 |
| Algorithm | 4.5 | 4.1 | 5.0 | 5.2 | 3.9 | 2.8 | 4.6 | 4.5 | 3.7 | 4.6 | 5.4 |

TABLE 2: Comparison of table data slicing operations.

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Traditional algorithm | 2.7 | 3 | 3.2 | 1.9 | 2 | 3.4 | 3.5 | 4.1 | 2.7 | 3.2 | 3.4 |
| Algorithm | 3.2 | 3.5 | 3.1 | 2.7 | 2.5 | 3.3 | 3.7 | 3.4 | 4.3 | 3.9 | 4.7 |

TABLE 3: Comparison of data accuracy.

| | 0 | 60 | 120 | 180 | 240 | 300 | 360 | 420 | 480 | 540 | 600 |
|-----------------------|------|------|------|------|------|------|------|------|------|------|------|
| Traditional algorithm | 0.27 | 0.30 | 0.32 | 0.26 | 0.25 | 0.41 | 0.40 | 0.39 | 0.32 | 0.37 | 0.41 |
| Algorithm | 0.33 | 0.31 | 0.3 | 0.18 | 0.22 | 0.17 | 0.26 | 0.25 | 0.42 | 0.50 | 0.52 |

attackers) deliberately falsify their local observation results, thus reducing the detection performance of aggregation nodes. To reduce the transmission and processing burden of sensor nodes, each sensor node generates bit local test statistics through energy detection and reports the test statistics to aggregation nodes. From Tables 1–3 and Figures 6–8, it can be seen that the accuracy of the algorithm in this paper is 19% better than the traditional algorithm. At the same time, the accuracy of the aggregated data increases over time as the channel congestion decreases in the traditional process.

Relax the prior condition of the real assumption, assuming that the damaged node (controlled by the attacker) does not know the real state of the target. For the aggregation node, it is assumed that it is not damaged, and test statistics are received from two types of sensor nodes (attacked and not attacked). Due to the limited energy of nodes in wireless sensor networks, energy consumption should be paid attention to while protecting the security of cluster head nodes. Data privacy protection not only is aimed at attackers, but also ensures that users' data will not be leaked and restored by attackers. At the same time, for other trusted users, ensure that these users cannot use the relevant key message they have to crack and restore the user's private data. It is assumed that the link transmission from the sensor node to the aggregation node is error-free. Consider an attacked wireless sensor network composed of N geographically distributed sensor nodes and an aggregation node, and detect unknown and definite signals. At present, the realization of secure data aggregation technique in wireless sensor networks mainly combines cryptographic mechanism and trust management model to effectively resist external and internal attacks, which complement and co-operate with each other. However, the combination of password mechanism and trust management mechanism cannot solve the question of data privacy protection perfectly.

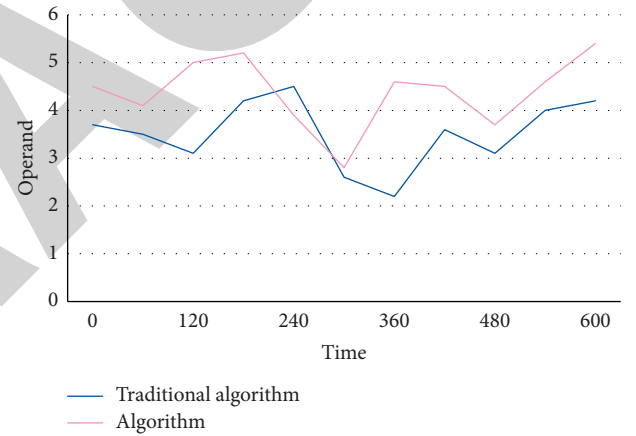


FIGURE 6: Operand comparison.

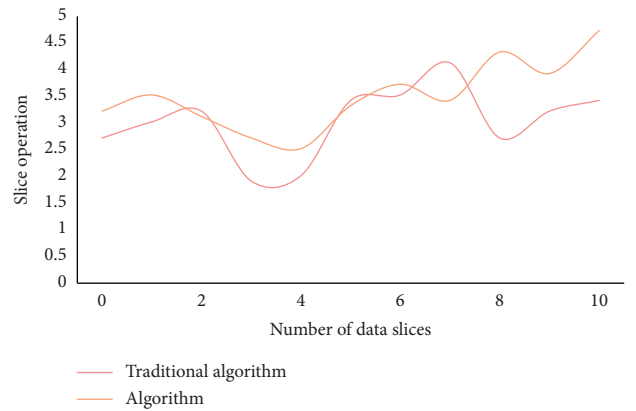


FIGURE 7: Comparison of data slicing operations.



FIGURE 8: Comparison of data accuracy.

5. Conclusions

With the large-scale popularization and application of WSNs, wireless sensors are playing a more and more important role in military affairs, life, and medical treatment, which brings convenience to people, but also brings some hidden dangers in data security. How to protect the privacy of data in WSNs is not only a difficult question in real life, but also a hot issue in academic research. Data aggregation technique can effectively remove redundant message, reduce data transmission, improve message acquisition accuracy and collection efficiency, and prolong network life cycle. It is one of the energy-saving techniques widely used in wireless sensor networks. However, data aggregation technique not only improves energy efficiency and message accuracy, but also has a certain degree of negative impact on security performance. How to balance the data aggregation function of wireless sensor networks and meet the security requirements in practical application scenarios is the key to design data aggregation protocols. This paper studies data aggregation means and digital sharing economy based on SURF algorithm and has achieved remarkable results.

Data Availability

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no competing interests.

Acknowledgments

This work was supported by Ningbo Philosophy and Social Science Research Base Project (JD5-ZD02) and National Social Science Fund Project (18FJY012).

References

- [1] P. Gazzola, G. Colombo, R. Pezzetti, and L. Nicolescu, "Consumer empowerment in the digital economy: availing sustainable purchasing decisions," *Sustainability*, vol. 9, no. 5, p. 693, 2017.
- [2] L. Nyhagen, "Book review: profit and gift in the digital economy," *The Sociological Review*, vol. 65, no. 2, pp. 426–429, 2017.
- [3] H. Park and C. Armstrong, "Collaborative apparel consumption in the digital sharing economy: an agenda for academic inquiry," *International Journal of Consumer Studies*, vol. 41, no. 5, pp. 465–474, 2017.
- [4] W. Sutherland and M. H. Jarrahi, "The sharing economy and digital platforms: a review and research agenda," *International Journal of Information Management*, vol. 43, no. DEC, pp. 328–341, 2018.
- [5] W. Shen, W. Xia, and S. Li, "Dynamic coupling trajectory and spatial-temporal characteristics of high-quality economic development and the digital economy[J]," *Sustainability*, p. 14, 2022.
- [6] R. Ginsburg, "Investor-state dispute settlement in the digital economy: the case for structured proportionality[J]," *Northwestern Journal of International Law & Business*, vol. 39, no. 2, p. 2, 2019.
- [7] D. Curran, "Risk, innovation, and democracy in the digital economy," *European Journal of Social Theory*, vol. 21, no. 2, pp. 207–226, 2018.
- [8] L. M. Dreyer, "Digital storytelling to engage postgraduates in reflective practice in an emerging economy," *South African Journal of Education*, vol. 37, no. 4, pp. 1–10, 2017.
- [9] Y. Hong, "Pivot to Internet plus: molding China's digital economy for economic restructuring? [J]," *International Journal of Communication*, vol. 11, pp. 1486–1506, 2017.
- [10] Y. Ding, H. Zhang, and S. Tang, "How does the digital economy affect the domestic value-added rate of Chinese exports?" *Journal of Global Information Management*, vol. 29, no. 5, pp. 71–85, 2021.
- [11] J. Lee, "Mediated religious practice: sharia digital economy in Indonesia," *Journal of Asian Studies*, vol. 24, no. 2, pp. 1–20, 2021.
- [12] S. Sultana, S. Akter, E. Kyriazis, and S. F. Wamba, "Architecting and developing big data-driven innovation (DDI) in the digital economy," *Journal of Global Information Management*, vol. 29, no. 3, pp. 165–187, 2021.
- [13] S. Y. A. Cho, "A study on China-asean digital economy co-operation," *Journal of Asian Studies*, vol. 24, no. 1, pp. 1–17, 2021.
- [14] Q. Ma, G. Mentel, X. Zhao, R. Salahodjaev, and Z. Kuldashaeva, "Natural resources tax volatility and economic performance: evaluating the role of digital economy," *Resources Policy*, vol. 75, no. 1, Article ID 102510, 2022.
- [15] S. Ren, L. Li, Y. Han, and H. Wu, "The emerging driving force of inclusive green growth: does digital economy agglomeration work?" *Business Strategy and the Environment*, vol. 31, 2022.
- [16] M. Sánchez, "A general approach on privacy and its implications in the digital economy[J]," *Journal of Economic Issues*, vol. 56, 2022.
- [17] S. Liu, W. W. Huang, H. Lu, and R. Watson, "Pacis 2019: emerging technology, business, and application in digital economy," *Information & Management*, vol. 58, no. 6, Article ID 103466, 2021.

Retraction

Retracted: Piano Intelligent Teaching Evaluation with IoT and Multimedia Technology

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] D. Wang and Z. Bai, "Piano Intelligent Teaching Evaluation with IoT and Multimedia Technology," *Mobile Information Systems*, vol. 2022, Article ID 7636458, 10 pages, 2022.

Research Article

Piano Intelligent Teaching Evaluation with IoT and Multimedia Technology

Dongkui Wang^{1,2} and Zuolian Bai³ 

¹Jinzhong Normal Junior College, Jinzhong 030600, China

²Philippine Christian University Center for International Education, Manila 1004, Philippines

³Shanxi Normal University, Taiyuan 030031, China

Correspondence should be addressed to Zuolian Bai; 703675@sxnu.edu.cn

Received 11 May 2022; Revised 4 June 2022; Accepted 7 June 2022; Published 4 July 2022

Academic Editor: Amit Gupta

Copyright © 2022 Dongkui Wang and Zuolian Bai. 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 deepening of the economic development process, the overall spiritual and cultural needs of the people have increased, and quality education has received more and more attention. Piano education is an important part of quality education. Nowadays, piano education has also been able to move forward continuously. As the king of musical instruments, the piano is widely used in music learning. Learning the piano can exercise willpower, develop intelligence, and cultivate sentiment. With development of computer software as well as hardware, Internet of Things technology and multimedia technology provide the material basis and preconditions for intelligent piano teaching. Therefore, how to evaluate the impact of the IoT and multimedia technology on intelligent teaching of piano has become a very important topic. Based on this, this work combines BP network with artificial fish swarm algorithm (AFS) and proposes network model (IAFS-BP) for evaluating the quality of piano intelligent teaching in the context of Internet of Things and multimedia. The specific contents of this work are as follows: (1) Aiming at the shortcomings of AFS, an IAFS with mutation operator, dynamic vision, and step size is proposed. (2) In view of shortcomings for BP network, IAFS is used in BP network. By using the IAFS algorithm in the training of the weights as well as thresholds, the training speed and training accuracy of the network are improved. (3) This work has carried out a comprehensive and systematic experiment to verify effectiveness and feasibility of IAFS-BP applied to quality assessment of piano intelligent teaching in the context of the IoT and multimedia.

1. Introduction

The piano is a harmonic instrument. From the perspective of the development history of the piano, it has countless excellent works, as well as solo pieces. This is the eternal spiritual wealth of human beings. Nowadays, while people are pursuing material wealth, spiritual wealth is gradually being valued by everyone. With the development of the times, people realize that material wealth does not necessarily make people noble, and the increase of spiritual wealth will improve people's spiritual realm, which is our real wealth. Learning the piano will allow us to experience, contact, and comprehend the spiritual wealth that people have been pursuing. Learning piano is of great significance. First, piano teaching helps to improve musical perception,

comprehension, and musical thinking. Second, piano teaching contributes to the healthy development of psychology, physiology, and thinking. Since piano performance requires active movement of each of the ten independent fingers, it requires excellent coordination and coordination of the whole body. Third, piano teaching helps to develop a good life style and spiritual quality. Fourth, piano teaching helps to improve psychological perception and self-regulation. During this period, the performer's ability to correctly understand other people's emotions is cultivated, and with the help of music, the ability to perceive other people's emotions is improved. In a word, learning piano plays a role in promoting all-round development, improving people's comprehensive ability level, and has important significance and effect on ability development and training [1–5].

Pianists can now use the Internet of Things and multimedia technologies to teach piano more effectively, thanks to computer software and hardware advances that have transformed the landscape. There is an Internet that connects things and things called the Internet of Things. Adapting to the times, it is also a component of the latest generation of information technology. On the one hand, the Internet of Things refers to a network system, but this system is based on the growth and extension of the Internet. Its core content and what plays a cornerstone role is Internet technology. On the other hand, the Internet of Things also expands the user side, and it is also applicable between items and items. This is to enable the exchange and communication of information between things. The Internet of Things is constantly growing, and many new technologies have emerged. Moreover, the corresponding technologies of the IoT in the fields of computing and perception have also been developed and expanded. The well-known third wave of world information development refers to development of IoT technology. IoT technology can be applied in life, which relies on the cooperation between objects, people and objects, and people. As a result, a network system that is larger and more complex than the Internet has been formed, and this system has also changed the relationship between people and things. This will not only have a greater impact on the existing way of life, but will also bring us great convenience and improve the efficiency of piano teaching [6–10].

Other types of vocal music, such as piano, and contemporary electronic music have become intertwined throughout the years. Throughout its history, it has been the result of the fusion of music and electronic technology. The term “multimedia” refers to the integration of computer technology with digital video and audio sources. Multimedia technology has the ability and precision to store enormous amounts of piano instruction materials, play films and music clearly, and help people learn, comprehend, and appreciate piano more vividly. Multimedia is a collection of piano teaching materials that can be used to teach piano. The composer employs diverse elements to edit, synthesize, and add various special effects to finally become a complete piano composition, according to the needs of production. The physical features of piano music are digitized and stored in multimedia devices as a means of disseminating it. The music from a digital piano is compressed, sent across a variety of mediums, and then played back when it has been received. Multimedia computers can help students learn the piano more effectively by combining video and audio elements. It is also possible to learn more thoroughly by interacting with the computer and the pupils [11–15].

Therefore, Internet of Things technology and multimedia technology have become an indispensable part of modern piano intelligent teaching. In this context, how to evaluate the quality of piano intelligent teaching under the networking and multimedia technology has become the top priority, which can effectively promote the healthy and rapid development of piano teaching. This work combines it with neural network and proposes a piano teaching quality assessment model based on the improved IAFS-BP algorithm. The specific contributions of this work are as follows: (1)

Aiming at the shortcomings of AFS, an IAFS with mutation operator, dynamic vision, and step size is proposed. (2) In view of shortcomings for BP network, IAFS is used in the learning process of BP network. By using the IAFS algorithm in the training of the weights and thresholds, the training speed and training accuracy of network are improved. (3) This work has carried out a comprehensive and systematic experiment to verify effectiveness of IAFS-BP applied to quality assessment of piano intelligent teaching in the context of the IoT and multimedia.

2. Related Work

Reference [16] pointed out that, because of the family conditions, living habits, and hobbies of each piano learner, they had completely different personalities. Piano teacher must be aware of the differences of each student, so as to truly teach students in accordance with their aptitude. Literature [17] pointed out that teachers should learn to encourage students more and encourage students every bit of their growth. At the same time, it was planned to point out mistakes made by students’ playing. Literature [18] pointed out that some parents blamed their children when they saw that other children’s progress in piano learning was so fast that their own children were left behind. Some teachers also lacked patience with students and could not wait patiently and cultivate students’ enthusiasm and autonomy in learning. If things went on like this, students would be resistant to learning how to play piano. For this type of students, we could only cultivate students’ interest in piano patiently and passionately, so that students could be more active in learning piano, and they could also cultivate their own sentiments. Literature [19] pointed out that students are in the growth stage, and their minds were still in the developmental stage. Because age, environment, and other aspects affected each student’s personality in a completely different manner, if a stereotyped teaching model was adopted, it was difficult to achieve an ideal teaching effect. Students who were more serious about their studies and had strong comprehension ability could be encouraged and praised, and students who were active in speaking can be praised orally. If teachers could encourage students and gave them some positive guidance, they could stimulate their enthusiasm for learning and enable students to better complete their learning tasks. Literature [20] pointed out that the introduction of cognitive theory into piano teaching should respect individual differences and cognitive abilities and pay attention to the chemical reactions between piano teachers and children, parents and students, and students and students. Literature [21] believed that the piano experiential teaching could be divided into four aspects: showing the situation through language, creating the situation through singing, simulating the situation through the body, and restoring the situation through performance, which helped to inspire students’ learning and thinking methods.

Literature [22] pointed out that the concept of the Internet of Things was to connect users and the surrounding environment through interfaces, so that they became an organic whole, thereby realizing the construction of a social

network. Literature [23] firstly expounded the specific content of the Internet of Things industry, emphasizing the importance of sensors. The development of industrial chains in various fields needs to rely on sensing equipment to integrate the information of objects into the network, so as to promote the effective supervision of equipment by the industry, so it had become the father of the Internet of Things. Literature [24] elaborated on the development of IoT industry from various aspects. IoT chain was a dynamic and continuous development process, and it formed a dynamic whole by aggregating networks and objects. Thereby, the information was exchanged, and it was not limited by time, and the timeliness was lasting. This enables different industries to have data on the processes they wanted to monitor anytime and anywhere. Literature [25] mainly focused on the two major aspects of safety and regulations. It believed that since security was the focus of global attention in the IoT industry, it was inevitable to conduct security analysis on the IoT operation interface. And it needed to match the corresponding laws to ensure that the IoT industry develops in the direction of legal compliance. Literature [26] pointed out that South Korea regarded the Internet of Vehicles as an important field for construction, and SK Telecom, the largest mobile operator in South Korea, had also established cooperative relations with many automobile companies and launched a variety of Internet of Vehicles products. It could carry out intelligent monitoring of automobiles, which was the application of IoT in Internet of Vehicles. Literature [26] pointed out that smart city was also an application field of IoT, and the most prominent was the construction of smart community. The United States built the world's first smart building. The building's health, light, electricity, and security were all realized with IoT. Reference [27] proposed that the United Kingdom invested a lot of research funds and government subsidies in Internet of Things research in 2015, and the research fields included eight fields such as transportation, energy, and environment.

Literature [28] believed that multimedia technology was the integration of modern technologies such as computer technology and information technology. Integrating multimedia technology into teaching could help enrich teaching content and teaching form. Literature [29] believed that multimedia teaching could deepen and optimize the educational process. Deepening was reflected in educational content, and optimization was reflected in educational methods. With the help of multimedia, the deepening of teaching materials and teaching materials could be realized. At the same time, it could also change the traditional teaching method with the help of multimedia and realize the optimization of the teaching method. Literature [30] believed that the deep integration of multimedia teaching and classroom could present a new learning environment. And it realized the organic connection with the teaching structure. Literature [31] believed that multimedia teaching had many advantages, but it was necessary to notice disadvantages in process of applying multimedia teaching. Therefore, in process of using multimedia teaching, it was necessary to adopt different application frequencies and application methods in combination with different actual situations.

Only in this way could students' enthusiasm for learning be fully mobilized.

3. Method

How to evaluate the quality of piano intelligent teaching under background of IoT and multimedia technology is an important topic. This work proposes improved IAFS-BP algorithm to solve this problem.

3.1. BP Network. The BP learning algorithm makes the problems existing in the learning method of the forward neural network get a new way of improvement, which greatly promotes the research work related to the forward neural network. With the in-depth research on neural networks, artificial neural networks are more and more applied to solve practical problems in life, and 80%–90% of them use BP neural networks. BP neural network can simulate nonlinear mathematical models and realize their mapping. It is widely used in target identification, condition monitoring, machine learning, and trace element determination.

Mainly through the following aspects to study the BP network: (1) Improve the activation function: the BP algorithm uses sigmoid function as activation function. When the input is too large or too small, the output will enter the saturation region, and the error will be relatively large, resulting in the algorithm not converging. Add a steepness factor to the activation function to improve the non-convergence problem of the algorithm. (2) Weight optimization, generally by improving the numerical optimization method, the standard gradient descent method, or the numerical approximation method to improve the neural network weight: The employment of algorithms such as the genetic algorithm, particle swarm algorithm, or simulated annealing method to improve numerical optimization is widespread practice. (3) Network topology: BP network is made of input layer, hidden layer, and output layer. There is no clear statement on calculating hidden layers in actual applications, and it is often decided by experience or trials.

There are three layers in a BP network: input, hidden layer, and output layer. The hidden layer might comprise many layers. BP networks have three layers. Unconnected functions necessitate two or more hidden layers, but in other circumstances only one hidden layer is needed. Any function can be mapped using the BP network. The number of hidden layers and the number of nodes in each hidden layer must be determined when creating the network's topology. Figure 1 depicts a typical BP network diagram. The input node of the input layer transmits the nonlinear signal to the hidden node of the hidden layer. The output node of the output layer examines and weights the output results after the information has been processed through the hidden layer. The output of the nodes in this layer in the network is only affected by the nodes in the previous layer.

Between the input and output layers, the hidden layer serves as the network's internal mode. Feature extraction on input data can be performed by the hidden layer and transmitted to the output layer, which can discriminate the

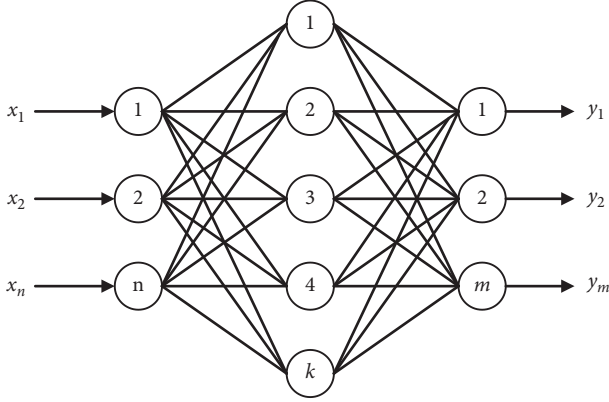


FIGURE 1: Structure of BP network.

input data from other input data. In the BP network, the initial network weights are randomly assigned, and through continuous adjustment, they become features that can express the input pattern.

To determine the number of hidden layer nodes, the number of nodes in the input and output layers must be taken into account, as well as the nature of the issues that need to be solved. The following conditions must be followed for determining the number of hidden layer nodes. It is essential that the number of nodes in the hidden layer is smaller than the sample count. Networks that include more hidden layer nodes than samples have a weak generalization ability and have no use in real applications. The number of training samples used in neural network learning is more than the number of link weights in the network, in order to accurately reflect the network's meaning. Choosing an optimum number of hidden layer nodes is critical when creating a neural network model. The network's performance will suffer if the number of nodes in the hidden layer is too small, and it will frequently fall short of requirements. Increasing the amount of hidden layer nodes will have a significant impact on the network's learning cycle, resulting in even more overfitting. The commonly used methods are

$$\begin{aligned} N_H &= A + 0.618(A - B), \\ N_H &= \log_2 A, \\ N_H &= \sqrt{A + B + C}, \end{aligned} \quad (1)$$

where A is input layer nodes, B is output layer nodes, and C is a constant.

Both input signal forward propagation and error signal backpropagation are key components of the BP network's learning method. The input signal is routed through the input layer to the hidden layer, where it is processed before being transferred to the output layer. Layer nodes in BP networks only respond to the status of their preceding layer nodes. The steering error signal propagates the process if the actual output differs from the expected output. If a mistake occurs during training, it is referred to as an error signal. The difference signal is sent back to the hidden layer in a certain manner and subsequently to the input layer. The error signals of the neurons in different layers can be retrieved by

returning the error to the neurons in those layers. Thereby, the related parameters of neurons in each layer are adjusted to achieve the optimization purpose of the network.

Taking the square of difference as error function, error can be expressed as

$$E = 0.5 \sum_{i=1}^N (t_i - o_i)^2, \quad (2)$$

where t_i is the true label, and o_i is the output.

The parameters are updated to

$$\begin{aligned} w' &= w - \alpha \frac{\partial E}{\partial w}, \\ b' &= b - \alpha \frac{\partial E}{\partial b}, \end{aligned} \quad (3)$$

where w is network weight, and b is bias.

3.2. Artificial Fish Swarm. In AFS, each fish is called a solution in the algorithm. Through the cooperation and communication of multiple artificial fish, place with highest food concentration, that is, global extremum, is jointly found. In the AFS algorithm, a group of artificial fish is initialized first, and the artificial fish updates its state by performing behaviors such as foraging behavior. After many iterations, the artificial fish finds the best value. In the algorithm, each artificial fish will move according to the state of itself and other artificial fish around, and each move of the artificial fish is equivalent to completing one iteration of the algorithm.

Foraging behavior is one of several examples of fish continually moving in the direction of greater food. Calculate the fitness value of a random state in the fake fish's field of vision, based on the fish's current state and fitness value. This is a more fit state for the fake fish when compared to the previous one based on fitness values. A random state is selected and the fitness values of the fake fish are compared. If the requirements are still not met, the action is performed again until the conditions for the next step are met or the number of search attempts is reached. If the artificial fish does not meet the conditions for the next step within the number of search attempts, the artificial fish will randomly swim in one direction within the maximum step size, and the artificial fish will reach a new state.

$$\begin{aligned} X_j &= X_i + RV, \\ X_{\text{next}} &= X_i + RS \frac{X_j - X_i}{X_j - X_i}, \\ X_{\text{next}} &= X_i + RS, \end{aligned} \quad (4)$$

where R is random function, V is the vision, and S is step size.

The swarming behavior means that individuals will flock to places where there are many fish, and individuals will move to the center of adjacent fish schools without causing congestion. In order to determine the set's fitness value, start

in the center. This indicates that if the conditions are met, the center position is better than the existing state of the artificial fish, and the region is not overcrowded. In order to avoid foraging, the mannequin fish swims towards the center.

The tail-chasing tendency suggests that the fish pursues the fish with the best state surrounding it. Otherwise, search for the quantity of artificial fish within its vision. If the conditions are met, it implies that the state of the optimal individual is better than the current state of the artificial fish, and the area is not congested, and the artificial fish travels in the direction of the optimal individual found; otherwise the foraging behavior is done.

Which behavior should be selected as the execution behavior in the actual movement of the artificial fish should be analyzed according to specific problems. In general, tail-chasing behavior is better than flocking behavior, and flocking behavior is better than foraging behavior. Therefore, the artificial fish can be made to perform the tail-following behavior first, and if the tail-following behavior does not make the artificial fish better or causes congestion in the area, the clustering behavior is performed. Performing flocking behavior still does not make the artificial fish get a better state or will cause crowding in the area and then perform foraging behavior. Each artificial fish will try to perform tail-chasing and swarming behaviors before iterating and select the behavior that can make the artificial fish easier to move to a better position as its own execution behavior. If the two behaviors cannot make the artificial fish move in the direction of a better state, the foraging behavior is selected as the next behavior of the artificial fish.

A bulletin board will be set up to keep track of the greatest artificial fish currently available. As soon as a fake fish makes a movement, it uses the fitness function to determine its fitness value and then compares it to the state with the best artificial fish. To replace the artificial fish on the bulletin board with an artificial fish that is in a better condition, relocate the artificial fish and the accompanying value to a new location. To find the best value, keep searching until the algorithm completes and the final bulletin board displays the best value. An efficient optimization method is achieved by the abovementioned behavior of an artificial fish swarm algorithm. When the algorithm is cut off, most of the artificial fish gather near several local extremums, and relatively more artificial fish tend to gather near the global extremum.

3.3. Improved AFS. When the artificial fish gather in a relatively flat area, this part of the artificial fish is easy to fall random swimming process without purpose. Moreover, some fish are also easy to fall into the vicinity of local extrema, which easily leads to longer algorithm convergence time and degraded search performance. In response to this situation, a mutation operator is added here. When the performance is not improved during the search process, the mutation operator plays a role to mutate the artificial fish in the group. In AFS, a bulletin board records optimal individual state found in the algorithm, and it can be determined whether the search result has been improved through the value change. If the value on the bulletin board does not

change after multiple iterations, mutation operation can be taken at this time. After the state of the optimal individual on the bulletin board is preserved, other artificial fish are initialized. In this way, the best individuals can be retained and other artificial fish can be prevented from doing useless work. This makes the fish jump local optimal solution to a certain extent and turn to find the global optimal solution.

The artificial fish swarm algorithm has higher global exploration capabilities and can fast converge if the selected vision is large. It is necessary to perform a substantial amount of math in order to account for the enormous number of artifactual fish that will be found. The algorithm's convergence slows down if the chosen vision is small. Although a higher step size helps speed up convergence, it is very easy to miss out on the best possible solution and the precision of the convergence is low. The accuracy of the algorithm can be improved by using a smaller step size, but this will have a negative impact on the method's speed of convergence. In this case, a dynamic vision and step size can be constructed, and while the algorithm runs, the vision and step size steadily decrease. Local search and convergence accuracy of the algorithm can be increased by setting up a dynamic vision and step size.

$$\begin{aligned} V &= D * V + V_{\min}, \\ S &= D * S + S_{\min}, \\ D &= \exp\left(-30 * \left(\frac{1}{K_{\max}}\right)^2\right), \end{aligned} \quad (5)$$

where V_{\min} , S_{\min} , and K_{\max} are set parameters.

With dynamic vision and step size, the artificial fish can fast converge in the early search period by making the vision and step size greater in the early stages. A reduction in vision and step duration can narrow the scope of a search in the later stages, which reduces computation time and improves search accuracy.

The fish can escape the search's local optimal result by introducing a mutation operator. Dynamic vision and step size establishment is proposed in the algorithm. Early on, the fake fish are given bigger vision and step sizes so that they can swiftly congregate in the vicinity of the extreme point of convergence. For better search accuracy, the algorithm's vision and step size are lowered in later stages. Thus, an improved artificial fish swarm algorithm with mutation operator, dynamic vision, and step size is provided herein. The pipeline of IAFS is illustrated in Figure 2.

Initializing the fish swarm is the first step, followed by assigning a random value to the artificial fish in the feasible region, determining the maximum number of trial iterations, determining the maximum number of times the artificial fish recorded on the bulletin board has not changed, and determining the artificial fish's vision and step size. As a second stage, each artificial fish's fitness value is calculated according to the fitness function, and a small artificial fish with the smallest fitness value is selected and placed on a bulletin board. Establishing a dynamic vision and step size is the third step in the process. By attempting tail-chasing and

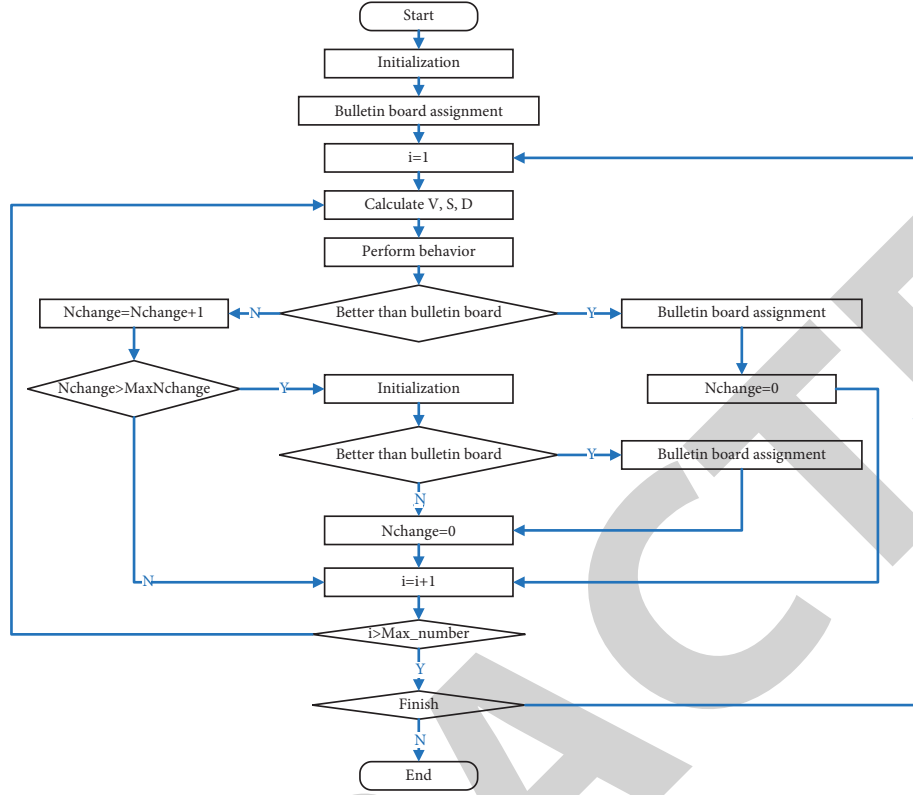


FIGURE 2: The pipeline of IAFS.

grouping behavior, the artificial fish will then pick whatever action makes it easier for the fish to go into a better position for its own execution. Foraging behavior should be employed if not. The artificial fish on the bulletin board will be compared to the state it was in after one repetition in the fifth phase. It records the relevant information of the artificial fish on the bulletin board if its own state is better than the artificial fish on the bulletin board. The sixth step is to determine the variation conditions. If the mutation condition is met, go to the seventh step; otherwise go to the eighth step. The seventh step is to perform the mutation operation. The eighth step is to determine the termination condition. In the ninth step, the algorithm terminates and the optimal solution found is output.

3.4. IAFS-BP Network. The BP network's learning algorithm uses the gradient descent approach, which is easy to fall into the extreme value, resulting in a slow learning speed, and lastly it is difficult to locate the global extreme value. An algorithm called AFS is based on swarm intelligence. To counter the problem of BP's network being susceptible to local extreme values, it has good global search capabilities. IAFS enhances the algorithm's global search and convergence speed. The convergence speed and training accuracy of the BP neural network can be improved by utilizing the IAFS algorithm to train the weights and thresholds of the network.

For a three-layer BP network, the optimized parameters of each neural network can be transformed into an artificial fish, so that each artificial fish can be expressed as

$$X = (v, u, w, t), \quad (6)$$

where v and w are network weight, and u and t are network threshold.

Individual differences or sums of artificial fish constitute BP networks, and the intended optimization variables of the BP network are the state of the artificial fish. The fitness function of the improved artificial fish swarm algorithm is based on the difference between the actual output value and the expected value of the network, which is produced by inputting samples in the input layer. The artificial fish swarm approach is used to train the BP network's weights and thresholds. Search ends when the network's output achieves a desirable level of error accuracy, and the searched network is now the optimal network. The fitness function is

$$Y = 0.5 \sum_{i=1}^M \sum_{j=1}^N (t_{ij} - o_{ij})^2, \quad (7)$$

where M is total samples, and N is neurons in output layer.

4. Experiment and Discussion

4.1. Dataset and Evaluation Metric. This work uses a self-made dataset to evaluate the quality of piano intelligent teaching in the Internet of Things and multimedia environment. The produced dataset is divided into training set and test set. The specific information is shown in Table 1. The input feature of each piece of data is a 9-dimensional index,

TABLE 1: The dataset information.

| Training set | Test set | Total set |
|--------------|----------|-----------|
| 3941 | 1503 | 5444 |

the specific information is shown in Table 2, and the corresponding labels are divided into 5 quality levels.

The evaluation used in this work is precision and recall; the calculations are as follows:

$$\text{Precision} = \frac{TP}{(TP + FP)}$$

$$\text{Recall} = \frac{TP}{(TP + FN)}$$
(8)

4.2. Evaluation on Network Training. In neural networks, the training of the network is very important. Only when the network can gradually converge can it be used for subsequent tests. To verify the convergence of the IAFS-BP method proposed in this work, its training loss and performance are first analyzed. The experimental results are illustrated in Figures 3 and 4.

As the training progresses, the loss decreases and precision increases. And when training reaches 60 iterations, both data indicators tend to converge, and the subsequent changes are small. This shows IAFS-BP method can be effectively trained.

4.3. Method Comparison. To further verify effectiveness for IAFS-BP algorithm applied to evaluation of piano intelligent teaching quality in IoT and multimedia environment, it was compared with other evaluation methods. The compared methods include logistic regression, decision tree, and SVM. The experimental results are illustrated in Table 3.

Compared with other evaluation methods, IAFS-BP can achieve the highest performance. Compared with the best-performing SVM methods in the table, 3.8% precision improvement and 3.6% recall improvement are obtained, respectively.

4.4. Evaluation on Mutation Operator. The mutation operator is used in the IAFS-BP algorithm. To verify effectiveness, this work compares evaluation performance with and without mutation operator. The experimental results are illustrated in Figure 5.

After using mutation operator, IAFS-BP obtains a precision improvement of 2.5% and a recall improvement of 1.8%, respectively, which proves the effectiveness and correctness of the strategy.

4.5. Evaluation on Dynamic Vision. The dynamic vision is used in the IAFS-BP algorithm. To verify effectiveness, this work compares evaluation performance with and without dynamic vision. The experimental results are illustrated in Figure 6.

TABLE 2: The data feature information.

| Index | Meaning |
|-------|-------------------|
| x_1 | Intonation |
| x_2 | Rhythm |
| x_3 | Speed |
| x_4 | Strength |
| x_5 | Accompaniment |
| x_6 | Teaching target |
| x_7 | Teaching content |
| x_8 | Learning attitude |
| x_9 | Teaching effect |

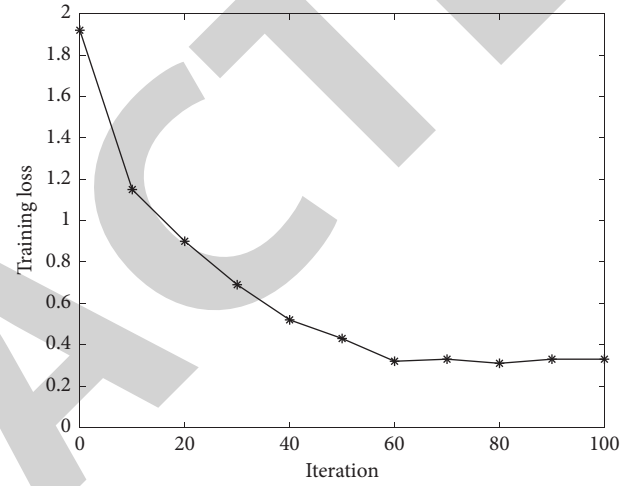


FIGURE 3: The training loss of IAFS-BP.

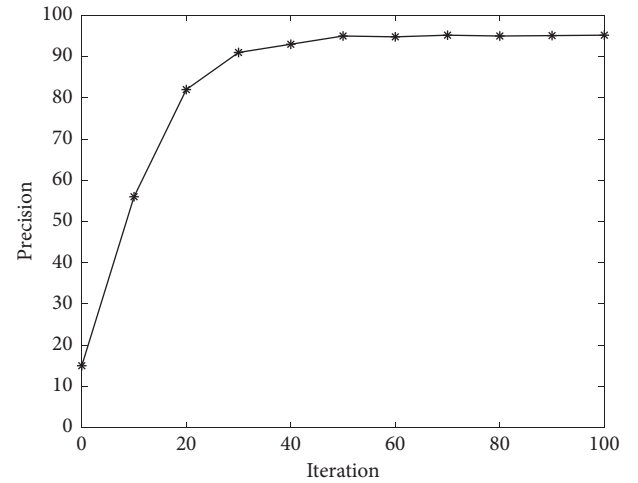


FIGURE 4: The training precision of IAFS-BP.

TABLE 3: Comparison with other methods.

| Method | Precision | Recall |
|---------------------|-----------|--------|
| Logistic regression | 85.3 | 82.2 |
| Decision tree | 88.3 | 87.5 |
| SVM | 91.4 | 90.1 |
| AFS-BP | 95.2 | 93.7 |

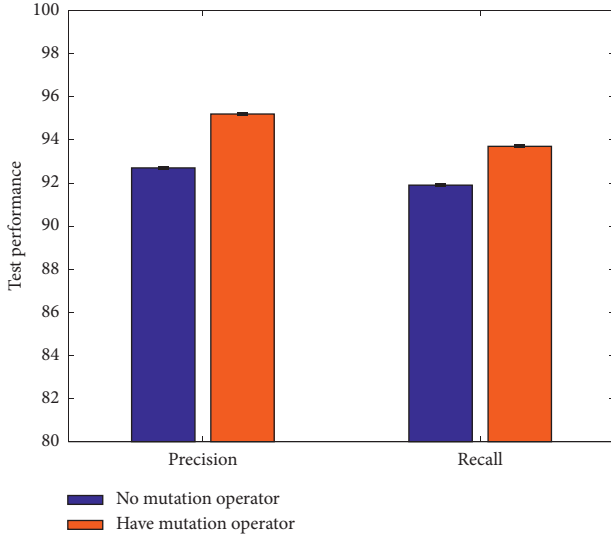


FIGURE 5: Evaluation on mutation operator.

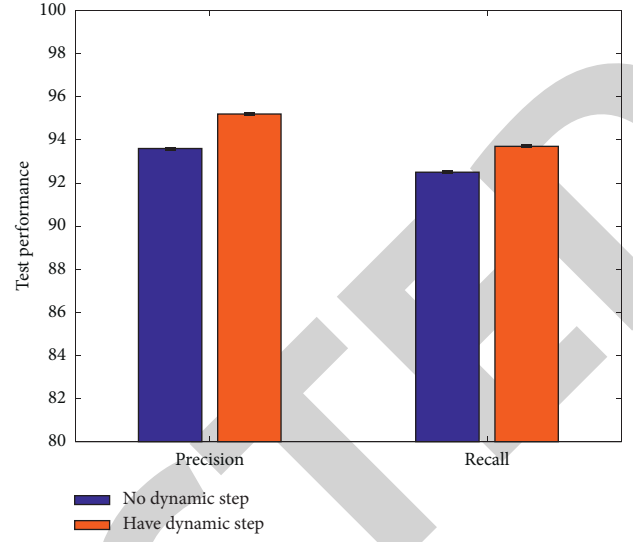


FIGURE 7: Evaluation on dynamic step.

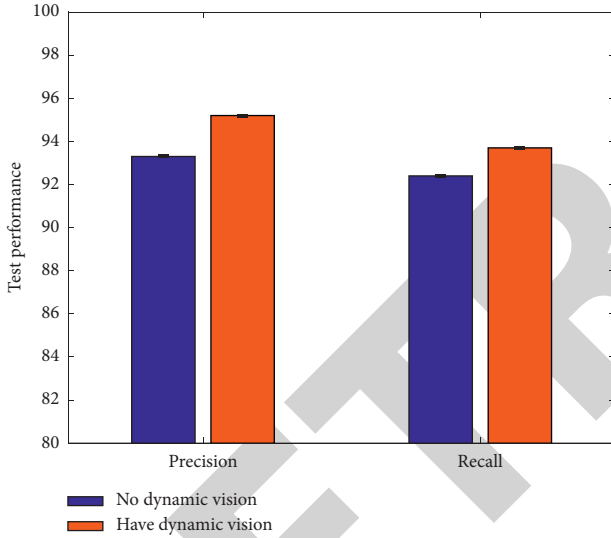


FIGURE 6: Evaluation on dynamic vision.

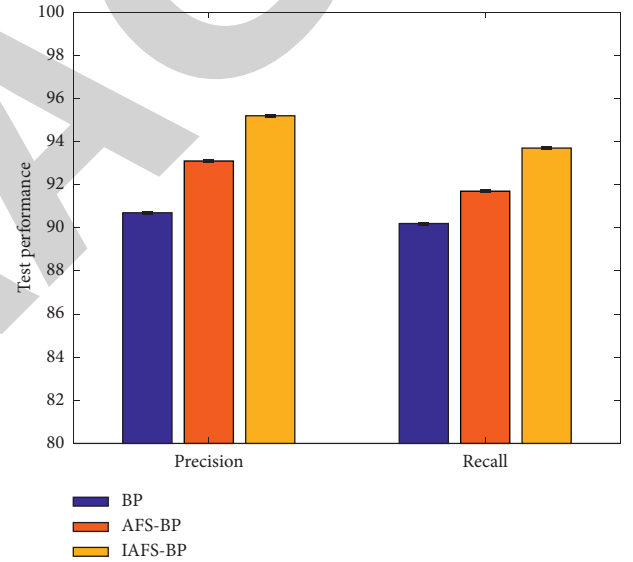


FIGURE 8: Evaluation on IAFS.

After using dynamic vision, IAFS-BP obtains a precision improvement of 1.9% and a recall improvement of 1.3%, respectively, which proves the effectiveness and correctness of the strategy.

4.6. Evaluation on Dynamic Step. The dynamic step is used in the IAFS-BP algorithm. To verify effectiveness, this work compares evaluation performance with and without dynamic step. The experimental results are illustrated in Figure 7.

After using dynamic step, IAFS-BP obtains a precision improvement of 1.6% and a recall improvement of 1.2%, respectively, which proves the effectiveness and correctness of the strategy.

4.7. Evaluation on IAFS. This work uses IAFS to optimize the BP network. To verify effectiveness, this work compares

evaluation performance of traditional BP algorithm, the AFS-BP algorithm, and IAFS-BP algorithm. The experimental results are illustrated in Figure 8.

The evaluation performance obtained by the traditional BP algorithm is the lowest. When the AFS algorithm is used to improve it, a certain degree of performance improvement can be obtained. When the AFS is improved, the evaluation performance can be further improved. This can prove the reliability and effectiveness of the IAFS algorithm proposed in this work.

5. Conclusion

At present, the upsurge of learning piano is constantly surging, and more and more students and parents can realize the importance of learning piano and the advantages it brings. With Internet of Things technology and multimedia

technology, as a fashionable and advanced teaching method, its ultimate purpose is to improve quality of teaching. IoT and multimedia teaching methods have natural advantages, which are reflected in the more flexible and diverse teaching methods for teachers. This can also track and manage students' learning results and processes in a timely manner, which is reflected in the students' interest and efficiency in learning, and better improves their ability. Over time, a virtuous circle has been formed between teachers and students, and the ultimate goal of teaching has been achieved. In this context, how to evaluate the quality of piano intelligent teaching under background of IoT and multimedia technology is an important topic. This work proposes an improved IAFS-BP algorithm to solve this problem. The specific results of this work are as follows: (1) AFS will fall into an invalid search process when searching for flat areas. AFS adopts a fixed vision and step size and has a fast convergence function. But later in search, most of the artificial fish were clustered in nearby areas. If the vision remains unchanged, the corresponding calculation amount will increase, and the step size will remain unchanged, which will prevent the artificial fish from moving in the optimal direction. This paper introduces an improved AFS algorithm. It can refine the search and improve search accuracy. (2) For network training, the BP algorithm not only takes a long time to train, but also tends to fall in local extreme values during training process. In this work, IAFS algorithm is used in BP network training. The improved IAFS-BP has better performance, such as global optimization ability, algorithm convergence speed, and search speed. (3) This work has carried out a comprehensive and systematic experiment to verify effectiveness of IAFS-BP applied to quality assessment of piano intelligent teaching in the context of IoT and multimedia.

Data Availability

The datasets used during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] T. Bobbe, L. Oppici, L. M. Lüneburg et al., "What early user Involvement could Look like-Developing technology applications for piano teaching and learning," *Multimodal Technologies and Interaction*, vol. 5, no. 7, p. 38, 2021.
- [2] Y. Fang, "Research on application of Ethnic music in piano teaching in colleges and universities[J]," *Art and Performance Letters*, vol. 2, no. 4, pp. 69–72, 2021.
- [3] Y. Fang, "Explore the new path of piano teaching in university under the background of internet information[J]," *Journal of Frontiers in Educational Research*, vol. 1, no. 6, pp. 94–97, 2021.
- [4] Z. Ning and L. Jia, "Research on the integration and development of internet piano teaching and traditional piano teaching[J]," *Frontiers in Art Research*, vol. 3, no. 8, 2021.
- [5] M. Liu and J. 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.
- [6] M. A. M. Sadeeq and S. Zeebaree, "Energy management for internet of things via distributed systems[J]," *Journal of Applied Science and Technology Trends*, vol. 2, no. 02, pp. 59–71, 2021.
- [7] J. Pei, K. Zhong, M. A. Jan, and J. Li, "Personalized federated learning framework for network traffic anomaly detection[J]," *Computer Networks*, vol. 209, Article ID 108906, 2022.
- [8] X. Lin, J. Wu, S. Mumtaz, S. Garg, J. Li, and M. Guizani, "Blockchain-based on-demand computing resource trading in IoV-assisted smart city[J]," *IEEE Transactions on Emerging Topics in Computing*, vol. 9, no. 3, pp. 1373–1385, 2020.
- [9] J. Wang, M. K. Lim, C. Wang, and M.-L. Tseng, "The evolution of the Internet of Things (IoT) over the past 20 years," *Computers & Industrial Engineering*, vol. 155, Article ID 107174, 2021.
- [10] V. Suma, "Internet-of-Things (IoT) based smart Agriculture in India-an Overview[J]," *Journal of ISMAC*, vol. 3, no. 01, pp. 1–15, 2021.
- [11] T. Kumar, S. Malabar, A. Benyo, and B. K. Amal, "Analyzing multimedia tools and language teaching," *Linguistics and Culture Review*, vol. 5, no. S1, pp. 331–341, 2021.
- [12] H. A. Susanto, T. K. Hobri, and T. K. Nugrahaningsih, "Developing a Handbook on multimedia integration in Mathematics teaching for Indonesian Primary school students," *International Journal of Education in Mathematics, Science and Technology*, vol. 9, no. 2, pp. 236–251, 2021.
- [13] W. Chen and F. Wang, "Practical application of wireless communication network multimedia courseware in college basketball teaching[J]," *EURASIP Journal on Wireless Communications and Networking*, vol. 2021, no. 1, pp. 1–21, 2021.
- [14] A. Haryudin and F. Imanullah, "The utilization of Kinemaster applications in the making of multimedia based teaching materials for English E-learning in new normal (Covid-19)," *PROJECT (Professional Journal of English Education)*, vol. 4, no. 2, pp. 341–352, 2021.
- [15] R. Song, "Research on the application of computer multimedia music system in college music teaching," *Journal of Physics: Conference Series*, vol. 1744, no. 3, Article ID 032214, 2021.
- [16] L. Li, "Study on the innovation of piano teaching in normal colleges and universities[J]," *Creative Education*, vol. 9, no. 5, pp. 697–701, 2018.
- [17] L. Simones, F. Schroeder, and M. Rodger, "Categorizations of physical gesture in piano teaching: a preliminary enquiry," *Psychology of Music*, vol. 43, no. 1, pp. 103–121, 2015.
- [18] G. Comeau, Y. Lu, and M. Swirp, "On-site and distance piano teaching: an analysis of verbal and physical behaviours in a teacher, student and parent," *Journal of Music, Technology & Education*, vol. 12, no. 1, pp. 49–77, 2019.
- [19] T. Yazici, "A study of developing Attitude Scale for piano teaching[J]," *Educational Research and Reviews*, vol. 11, no. 7, pp. 358–370, 2016.
- [20] Z. Nie, "Design and implementation of JAVA-based piano teaching management system[J]," *Educational Sciences: Theory and Practice*, vol. 18, no. 5, 2018.
- [21] 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.

Retraction

Retracted: Assessment and Test-Case Study of Wi-Fi Security through the Wardriving Technique

Mobile Information Systems

Received 8 August 2023; Accepted 8 August 2023; Published 9 August 2023

Copyright © 2023 Mobile Information Systems. 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] V. O. Etta, A. Sari, A. L. Imoize, P. K. Shukla, and M. Alhassan, "Assessment and Test-Case Study of Wi-Fi Security through the Wardriving Technique," *Mobile Information Systems*, vol. 2022, Article ID 7936236, 21 pages, 2022.

Research Article

Assessment and Test-case Study of Wi-Fi Security through the Wardriving Technique

Victor Ojong Etta ¹, **Arif Sari**,¹ **Agbotiname Lucky Imoize** ^{2,3},
Piyush Kumar Shukla ⁴ and **Musah Alhassan** ⁵

¹Department of Management Information Systems, Girne American University, Karmi, Northern Cyprus, Turkey

²Department of Electrical and Electronics Engineering, Faculty of Engineering, University of Lagos, Akoka 100213, Lagos, Nigeria

³Department of Electrical Engineering and Information Technology, Institute of Digital Communication, Ruhr University, Bochum 44801, Germany

⁴Department of Computer Science & Engineering, UIT, RGPV, Bhopal 462033, MP, India

⁵Electrical Engineering Department, University of Development Studies, School of Engineering, Nyankpala Campus, Tamale, Ghana

Correspondence should be addressed to Musah Alhassan; musahalhassan@uds.edu.gh

Received 16 May 2022; Accepted 17 June 2022; Published 30 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Victor Ojong Etta 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.

This study aims to investigate Wireless Local Area Network (WLAN) within the context of its applicability as a 21st-century business tool and its survivability in a security threat-infested cyber landscape. WLAN security leverages the Wardriving technique deployed within geolocation to scan for WLAN density and explore the associated security mechanisms. Specifically, the study adopts two approaches; the first part reviews relevant research articles in electronic libraries and databases on WLAN security based on wardriving techniques. The other part comprises a measurement campaign conducted in a mid-sized city in North Cyprus. The field measurement aims to underscore the claims from the literature to find out how the security encryption technologies are used. In particular, the goal is to determine the availability of WLAN infrastructure and monitor how the security measures are implemented in Northern Cyprus. The main objective is to determine the security state of WLAN in Cyprus and examine how it can be generalized for related environments. In order to completely grasp the research issue posed in this study, data analyses from several perspectives are analyzed and examined critically. The wardriving approach has been used in this work to crawl wider regions for examination. This study was conducted with security findings drawn only from publicly accessible information emitted by each investigated wireless access point. The channel usage, Service Set Identifier (SSID) security, the Encryption type (Open, WEP, WPA, WPA2, WPA3, and Mixed mode), WPS usage statistics, geographical locations, detailed security statistics described in Wigle CSV format, and vendor statistics are highlighted. Generally, results indicate that 21,345 WLANs were detected. From the detected WLANs, 23 (0.1 percent) used WEP encryption, 18 (0.08 percent) used WPA-TKIP encryption, 5,359 (25.1 percent) were unencrypted, and a clear majority of 9,139 (42.82 percent) used the more secure WPA2 encryption, while 13 networks (0.06 percent) used the latest WPA3 encryption technique. The results imply that WLAN security in Cyprus can be said to be moderate. Thus, this study adds to the expanding corpus of research on WLAN security and Wardriving to all parties in the wireless security ecosystem. The current study examines WLAN operations in North Cyprus while pointing to future research directions on Wireless LAN security mechanisms. Overall, the dataset from the wardriving experiment is novel and would serve future research exploration in the wireless security systems domain.

1. Introduction

Wireless LANs have recently been widely used in commercial organizations, airlines, hospitals, schools, and residences. However, considerable WLAN is used in Small Offices and Homes (SOHO). Wireless Local Area Networks, or Wi-Fi, are the primary Internet connection for individuals and organizations. The 1997 release of IEEE 802.11 WLAN standards contributed to the increase in popularity of WLAN to become the ubiquitous connectivity solution for many users globally [1]. Its low latency, high transmission speed, low cost, and high stability are critical to its popularity. WLAN will reach more than \$3.47 trillion in 2023 [2]. The present spike in WLAN-enabled smart homes and Internet of Things (IoT) devices is expected to increase WLAN equipment to 17 billion by 2030, as 5 billion devices were anticipated in 2019 [3]. Mobility, scalability, flexibility, cost-effectiveness, simplicity of deployment, and other considerations contribute to WLAN spread. However, one of its major drawbacks is that from inception, security was not a consideration in its design, and owing to its broadcast nature, it is susceptible to security attacks. So, despite WLAN's popularity, its technology makes it unsafe because WLANs transmit radio signals for clients to receive. Unauthorized users sometimes position stations to listen for covert criminal activities. Whether at home or the workplace, understanding wireless connectivity and the risks and vulnerabilities involved with its use are crucial concerns for end users. Although some Wi-Fi security mechanisms established to protect wireless LAN had been in line with IEEE 802.11 standard, these security mechanisms were intended to secure WLAN through authentication and encryption [1]. They include WEP (Wired Equivalent Privacy), WPA (Wi-Fi Protected Access), WPA2, and WPA 3. Some factors that influence the security of Wi-Fi wireless networks include standards, conventions, and good practices [4]. In general, WLANs are vulnerable to both passive to active attacks.

A comparative analysis of the wide application of wireless network communication and the inherent security implication does not seem to deter the high acceptability rate and adoption of wireless network communication by individual users, small businesses, and the enterprise group. In small businesses, WLANs boost productivity and enhance information sharing. The ease of access to documents is untethered. Employees can move around and always have access to the tools they need to conduct their duties. Wireless network communication benefits include increased mobility, collaboration, responsiveness, information access, network growth, and guest access. They now exist in Smartphones, Tablets/Pads, Palmtops, Smart televisions, wireless routers etc., which are used as intermediate and endpoints in wireless networks. Wireless LAN can be said to be the main hub of business communication in everyday life. The growing popularity of the Internet of Things (IoT) in smart homes and cities is built around Wireless LAN or the other [5].

There is a concentration of WLAN adoption in urban and/or business districts relative to the rural area. A simple

survey shows that the urban human population, small businesses, and Corporations are found in urban districts, which explains the dense nature of WLAN technology [6]. Another factor contributing to the popular use of Wi-Fi networks is its portability and mobility, low cost, and ease of deployment. Wi-Fi technologies are said to be insecure, and this stems from the broadcast nature and low-security considerations on intermediate and endpoint devices [7]. For this, techniques such as Wardriving or Access Point mapping were developed to study the security mechanisms to demonstrate privacy vulnerabilities while educating the growing population of users on which security mechanisms to adopt to mitigate attacks.

1.1. Wardriving. The term Wardriving describes the technique used for searching and mapping WLAN signals within a particular location or district. Wardriving is generally defined as moving around (not necessarily in an automobile) a designated geographical area and scanning to enumerate wireless access points and their operational state in real time. The statistics reveal the security posture of these types of networks [8]. Wardriving is often a passive experiment that targets publicly available information from each wireless access point [9]. It typically requires a laptop or an Android device (smart phone or Tablet). A USB-powered WNIC and a GPS receiver make the laptop a more effective tool because of its higher processing power. It is now possible to deploy freely available open-source and Wigle software and Android hardware devices to perform wardriving.

1.2. Legality of Wardriving. Wardriving is not hacking, illegal or damaging activity to assessed wireless network devices or their owners, despite its name seeming illegality. According to Wargames (1983), the term "Wardialing" was developed when a computer was used to call a series of numbers to locate other computers having networking capacity [10]. Depending on the equipment and the objective of the survey, wireless network scanning can be active or passive. The active scanning approach requires the wireless scanning device to connect with the devices that are being scanned. This can be accomplished by transmitting and collecting probe request frames from adjacent WLAN devices. It is like wardialing, where the devices are plotted based on the responses.

Wardriving is sometimes misunderstood as a form of hacking due to its deceptive name. Contrarily, Wardriving is a widely accepted tool used by professionals and amateurs in information security. Wardriving can become criminal if used to violate a wireless network's security. This may involve scanning susceptible WLAN networks to acquire unauthorized access. Because of misunderstandings and possible misuse of Wardriving, it is critical to understand the legal and regulatory limits. There appears to be a great deal of ambiguity in determining what constitutes authorized and unauthorized access for the Open WLAN networks [11, 12]. Unauthorized Wi-Fi access (or piggybacking) raises fresh and contentious legal challenges. Regulating open WLAN access is currently uneven and confusing in many areas. This

leaves roaming Wi-Fi users unsure of their legal standing while connecting to an unknown open network [13].

1.3. Common Security Threats to WLAN. Confidentiality, Integrity, and Availability (CIA triangle) are the most important assets in computer networks and resources. The CIA triad is a concept that serves as the foundation for establishing an organization's security systems and policies. When the CIA criteria are satisfied, an organization's security profile becomes stronger and better suited to address the threat occurrences. The CIA triad offers a detailed high-level checklist for assessing security processes and equipment. An effective system meets all three components, whereas an information security system that lacks any of the three characteristics of the CIA triangle is inadequate and vulnerable to threats and assaults. A threat is a prospective security breach that has the potential to take advantage of a system or asset vulnerability. Whether passive or active, an attack is an intentional unauthorized action against a system or its asset.

Wireless local area networks (LANs) are prone to security breaches. In 2018, a data security breach affected two-thirds of small and medium-sized businesses (SMBs). The average attack cost on these companies was over \$3 million, owing to protracted system failures (40 percent of servers were down for more than 8 hours), which increased the average cost to over \$3 million. [14] Wireless network attacks may occur from misconfigurations or incomplete configurations. These include Denial of Service, Resources hijack, Backdoor intrusion; the passive gathering of sensitive data through eavesdropping within range of an access point, Rogue (or Unauthorized/Ad Hoc) Access Points: that deceive devices into connecting; attacks by impersonating legitimate access points to convince authorized users to sign-on, hacking Lost or Stolen Wireless Devices: getting past the password, freeloading: stealing a connection or stealing files. Figure 1 summarises wireless network attacks and threats that network administrators and users contend with maintaining safe network infrastructures.

1.4. Motivation. The significance of wireless network security assessment stems from the necessity to address the issues, ascertain the key sources of security flaws, and devise methods to mitigate them.

The primary motivation:

- (i) To better understand the ubiquitous and pervasive nature and the exponential growth of WLAN devices, intensified by the advancements in wireless technology, declining cost and simplicity in deployment.
- (ii) Despite extensive research on WLAN security challenges spanning about 20 years, there are still a plethora of security challenges in Wi-Fi networks.
- (iii) There is a need to understudy the vulnerabilities and cyber-attacks associated with WLAN and how to mitigate them or minimize their impact.

- (iv) The fast growth of IoT enabling technologies has exacerbated the dependency on WLAN as an underlying hub; thus, security concerns are becoming increasingly significant and capturing public attention.
- (v) A wide range of Wi-Fi-based Internet of Things applications are available, from smart homes to smart cities, but security problems exist.
- (vi) WLAN security has remained elusive, necessitating on-the-move (OTM) WLAN scanning to successfully infer the condition of WLAN in any given location.
- (vii) Despite the widespread availability of wireless connectivity, most wireless users are either unaware or unable to deal with wireless security issues. Consequently, we now have the most serious security vulnerability to hit computers in decades.

The significance of wireless network security evaluation stems from the necessity to address the issue to ascertain the key sources of security flaws and devise methods of mitigating them. Therefore, pursuing research in WLAN based on wardriving techniques will enhance the knowledge of the underlying security mechanisms and users' behaviour towards a resilient WLAN and open a new gateway for future research endeavours.

1.5. Contribution. The main contributions of the paper are outlined as follows.

- (i) We carried out extensive reviews of research articles on WLAN security based on wardriving techniques by searching relevant literature in electronic libraries and databases.
- (ii) We conducted a measurement campaign in a mid-sized city in North Cyprus to underscore the claims from literature, intending to find out how security encryption technologies are used.
- (iii) We determined the availability of WLAN infrastructure and monitored how security measures were implemented in Cyprus.
- (iv) We investigate a Wireless Local Area Network (WLAN) within the context of its applicability as a 21st-century business tool and its survivability in a security threat-infested cyber landscape.
- (v) We examined WLAN operations in North Cyprus while pointing to future research directions on Wireless LAN security mechanisms.

1.6. Paper Organization. The structure of this work is as follows. The first Section gives the background information on wireless local area network, its growth and ubiquity, security issues and encryption protocols, common security threats, wardriving, the legality of Wardriving, and the research motivation. Section 2 summarises related literature. In Section 3, we cover the research methodology. Similarly, in Section 4, we address notes on the selected studies. In

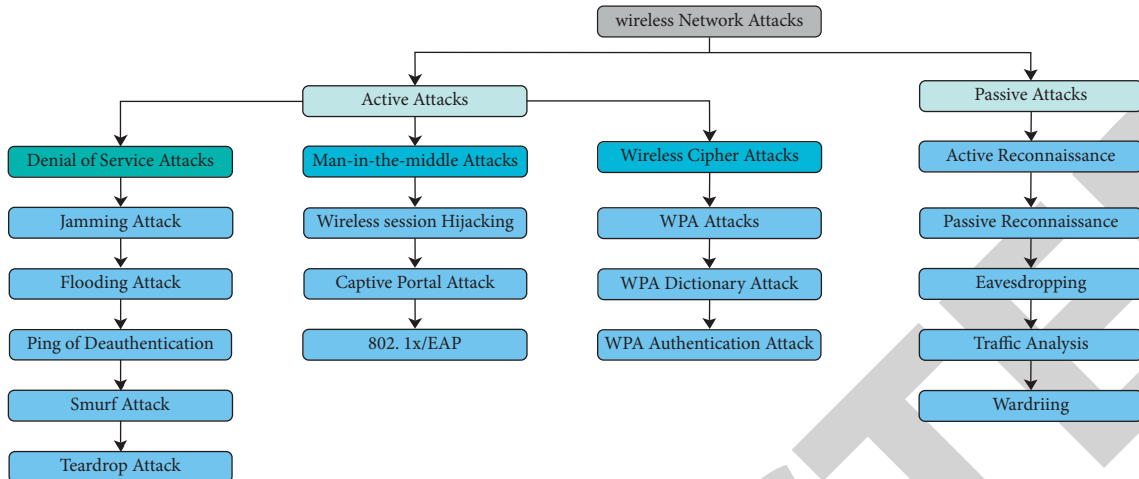


FIGURE 1: Common WLAN threats and attacks.

Section 5, we perform a test case scenario of the wardriving technique in Girne, a mid-size city in Cyprus, to underscore the rich literature on the subject, and present the limitations of the survey and survey results. Finally, Section 6 concludes the survey.

2. Related Work

Several research works have been carried out in Wireless network communication in general and wireless network security in particular. The next section of this review addresses the articles based on the title of this paper. It is hoped that at the end of the review, concrete recommendations on wireless security infrastructure in different scenarios attract appropriate security approaches for wireless infrastructure while pointing to future research directions in Wireless LAN security. Wardriving, a term coined by Shipley (2000) after an 18-month study of WLAN, was presented at the DefCon conference of 2001 [15]. He referred to wardriving as “driving around and looking for wireless networks” [16]. Webb [17], Yek [18] and Lin, Sathu, and Joyce [19] conducted surveys of WLAN networks in Australia and New Zealand in 2003. According to these early surveys, regular consumers were not yet aware of the benefits of encryption. They found that only 40% of studied WLAN networks use encryption. However, with the growth in density of WLAN, the proportion of encrypted networks fell, according to Webb and Yek. Because WLAN technology was new to the consumer market in the early 2000s, users may have been unfamiliar with it. WLAN standard was only finalized in 1997 by IEEE 802.11, while Apple was the first manufacturer to deliver built-in WLAN networking for laptop computers in 1999 [20]. Hence user experience was at its prime.

The authors of the work reported in [21] used data from 2003, 2007, and 2010 to investigate the progress of WLAN availability and security in Auckland, New Zealand. The findings from the study indicate a 406 percent increase in total WLAN adoption from 2003 to 2010. Additionally, the authors demonstrate a 48 percent rise in the adoption of encryption protocols since 2003, to 88 percent of all

observed networks in 2010. In 2015, the authors of the work [22] surveyed WLAN users in the Auckland neighbourhood. The authors reported a 1600 percent rise in overall WLAN deployment, observing an increase from 236 to 4077 unique networks. According to the data presented by the authors, encryption protocol utilization grew to 100% in 2015, compared to 40% in 2003. The data revealed that 71% of the investigated networks applied the WPA2 encryption technique.

In New Zealand, a comparable increase in WLAN security and density was reported by [23, 24]. According to Nisbet’s results, the evolution of Wi-Fi security in four distinct sites around New Zealand using survey data from 2004 to 2011 depicted that WLAN deployment rose by 2600 percent in one investigated location. WLAN deployment surged by more than 700 percent in another assessed location during the same period. In 2013, encryption protocol adoption varied significantly amongst the investigated areas, ranging from 77 percent to over 97 percent. Related studies reported by [25, 26] are highlighted in this paper.

Recent Wi-Fi network survey research in Europe has focused on the Balkans. The work reported in [27] evaluated the prevalence and security of WLANs in Budapest and Belgrade. Approximately 90% of examined networks use some version of WPA encryption in both locations, leaving less than 10% of networks unprotected and less than 2% using WEP encryption. The works [28, 29] provide similar findings. Leca’s research gathered data from over 100,000 wireless networks located throughout Romania. 86 percent of the 100,000 networks were encrypted with WPA2, 5% with WPA-TKIP, and 3% with WEP, leaving the other 6% unprotected. Over 11,000 WLAN networks in the Bulgarian city of Varna were investigated by Valchanov et al., who observed encryption usage rates almost identical to those reported by Leca.

In the work of Valchanov et al. [9], the authors researched wireless security in Varna city, Bulgaria, through a wardriving method using Raspberry Pi. The results were compared with previous research conducted in 2008. The analysis of the Wi-Fi security posture of Varna showed that

there had been a significant improvement from previous research. They recommended that only WPA2 or higher security protocols be used. Where there is a need for older devices, separate and limited networks can be used to support WPA/WPA2 mixed mode, and WPS settings should be disabled from all access points. For future work, they suggested more research on 802.11ac and 802.11ah networks in the greater Varna area [9].

A review by Sebbar et al. [25] performed a Wi-Fi network measurement campaign in Rabat, Morocco, through Wardriving. They covered about 10,000 WLANs comprising both for private and business use. They reported that 77% of the networks used WPA or WPA2 security protocols and balanced the use of nonoverlapping channels (1, 6, and 11) to avoid interference. They concluded that WLAN security in Morocco is comparable to what exists in the developed countries. They, however, noted that the results of their research might not be generalized to other cities for reasons such as socio-economic and educational differences in Morocco [25].

The wardriving technique was useful in mapping Wi-Fi networks with given landscapes and gathering data on devices used for criminal activities such as terrorism. In passive mode, information from digital devices can be easily collected. [26] opined that such gathered data can be used by law enforcement agents to track the criminals. In the evaluation of Wi-Fi security in one of Malaysia's major cities, conducted by [27], where passive data traffic of private homes, coffee shops, and companies were collected and analyzed using Kali Linux operating system tools to create awareness of the lapses in their wireless network environment; the result of the evaluation shows the lack of security awareness among people thus exposing them to threats such as Spoofing, Tampering, Repudiation, Information disclosure Denial of Service, and Elevation of privileges (STRIDE). The experiment results show that no fewer than 9 out of 1,282 access points were found to disable broadcasting their Service Set IDs (SSID) or names of the access points. The study also found that 19.73% (253 AP) do not use encryption. In other words, they are open access points. The result also shows that 16.77% (215 AP) implemented WEP encryption protocol while 63.7% (814 AP) implemented WPA/WPA2 encryption [27]. They recommended enforcing strict regulations on public places that use wireless access points and embarked on a campaign advert on YouTube to create awareness of the implication of operating an unsecured wireless network.

In the work of [28], the author focused on the ease of compromising Wireless networks as a result of unprotected devices revealed high positives. He maintains that finding open wireless networks was commonplace in Eger. However, his research shows that vulnerability in wireless networks is attributive to those user groups that are less familiar with the use of the Internet. Another susceptible user group is the Z generation (anyone born from 1997 onward). Generation Z has been dubbed "digital natives" who share Internet access on the open network [28]. The researcher concluded that the users are ignorant of possible threats through some IT devices. He further recommended that strong passwords be

used as an additional layer of defence mechanism from attacks when sharing Internet or data traffic.

The study of [29], argues that a false sense of security by Access point administrators is responsible for the neglect of adopting the needed encryption protocols for the security of Wi-Fi networks. The researchers suggest implementing a simple program to determine the security state of the Wi-Fi network and its conformity with the current Wi-Fi security best practices. In conclusion, the authors admit that the poor Wi-Fi security is a growing concern for private and business use needing urgent attention. They urge relevant authorities to mandate effective Wi-Fi security measures and compliance.

A study by [30] in selected cities in Lebanon aimed at raising awareness of the inherent threats and their impact on WLANs using the wardriving techniques. The main contributions of the study were raising awareness of flaws and vulnerabilities of existing Wi-Fi networks, the severity of Wi-Fi network attacks, and steps on how to improve Wi-Fi security procedures [30]. The authors observed that people are unaware of the Wi-Fi attacks and threats they are susceptible to from the study. They recommended that there is a need to conduct security awareness campaigns through conferences and workshops to educate users on the different Wi-Fi attacks, their severity, the threats they portend, and measures to alleviate attacks. In the same vein, the work [31] maintains that developing educational programs that inform the average consumer of inherent threats and the methods for securing wireless networks is a necessary tool to be explored.

The submission of [32] proposing wardriving as a system that can assist in collecting Statistical data of WLANs and their security status in a mapped geographical area suggests that the application can be used to study security trends and threats, misuse, and exploitation of Wi-Fi infrastructure. Although Wardriving is often regarded as a controversial practice, they added that it has helped raise awareness of the significance of WLAN security. It can be argued that some key objectives of their study were to increase the efficiency of Wardriving and awareness of WLAN network security, as well as to create a technique of quickly capturing and storing statistical and location information of WLAN networks within predetermined zones.

In dealing with the problem of "digital inclusion in the Ecuadorian Amazon," which was exacerbated by the pandemic, wireless access point mapping (WAP) or Wardriving was employed to map and analyze data correlating it with geoinformation to observe its potential and limitations as a method for indirect data collection [33]. They argued that Wireless access points correlate weakly but positively with nightlight, young population, accessibility to economic centres, and negatively with slope [33]. The researcher concluded that Wardriving offers interesting opportunities for mapping social data and an indirect data collection method. They submitted that Wardriving offers new opportunities to explore the vast variability of existing sensors and supply data needs for different scientific disciplines.

The objective of the work in [34] is to provide a technique for collecting, analyzing, and storing WLAN survey

data that is efficient, scalable, and easily accessible. This was accomplished using wardriving with publicly available open-source software and commercially available hardware. Despite its threatening nickname, they asserted that Wardriving is neither unlawful, malicious, nor detrimental to the surveyed wireless network devices or their owners. They suggested that future studies will improve the accuracy of surveyed results by investigating newer Wireless Interface Cards (WNICs) and various antenna types. Additionally, the method for data analysis must be enhanced as, over time, the amount of WLAN data increments. They stated that future work should focus on improving data storage, sampling techniques, and increasing sample size covering a larger WLAN networking landscape for a more extensive investigation.

The work reported in [35] posits that only a little research exists on statistical issues with wardriving data, despite several published works in the literature using this approach. The authors sampled publicly collected wardriving data and compared it with a predictive model for Wi-Fi access points to buttress this point. The outcome shows several statistical issues which future wardriving researchers must account for, which include “selection bias,” “sample representativeness,” and the “modifiable areal unit problem.” Their methods include opportunistic Wardriving, using the Wigle app on an Android Google Pixel 4 to develop a self-collected geolocated Wi-Fi AP dataset as a predictive model for Wi-Fi density using national statistics and comparative evaluation of the different quantitative datasets on Wi-Fi Apps. By taking account of these factors, we hope that future wardriving exercises will be able to provide more rigorous and robust statistical assessments of Wi-Fi APs. The work of [36] deals with WLAN security technologies and their potential for integrity, availability, and confidentiality. It provides a thorough analysis of most WLAN packet data services and technologies.

The research purpose of [37] is to design a method for surveying wireless local area networks, assess the present state of WLAN security, and ascertain the extent to which the outdated encryption technologies are still utilized in Finland. The method of WLAN surveying should be efficient, scalable, and easily replicable. Additionally, it should ascertain the current condition of WLAN security in Finland through observation of WLAN security practices. By using the wardriving technique, a passive wireless network scanning was used to gather information about nearby wireless networks by listening for messages broadcast by wireless network devices. The author concluded that scanning WLANs using the wardriving technique accomplished the research’s objective. However, he emphasized the importance of refining the wardriving process in a future study by enhancing surveying software, hardware, and methods and scaling up the research to broader locations. Additionally, the author recommends using a separate WLAN adapter for the 2.4 and 5 GHz bands and equipping the adapters with more powerful antennae.

An analysis of Wi-Fi network security based on publicly available datasets was performed through an experimental survey covering several networks across four countries on

three continents [38]. The study revealed the consistent use of outdated, vulnerable security settings, the adoption of modern protocols, the increased presence of mesh networks as part of smart city infrastructure, and the frequency spectrum. It also provided a clearer view of Wi-Fi network security in the real world. As a contribution to the research community, tools used for mining security statistics and all anonymized datasets were made available to would-be researchers in the domain.

Wi-Fi network security status of occupants in coffee houses in Libya is the work of [39]. The objective of the study was to evaluate security vulnerabilities in the use of WLAN by the population. Data was acquired through wardriving techniques from different populated locales. The analyzed data provided insights on wireless security awareness among the public. Their result showed that the security status in the public WLAN needs improvement, hence the need to implement sophisticated passwords and configure the encryption to WPA2.

The legal and security framework of Wardriving is the focus of [40]. It has been argued that wardriving is a form of hacking as opposed to an ethical approach to enhance WLAN security. These authors suggest that a technical and legal policy framework for Wardriving be formulated to guide scientists, managers, technologists, and the government. To substantiate the call, the researchers developed a preliminary and novel Mobile Enterprise Security and Legal (MESL) Framework. The study reported in [41] performed through field evaluation of WLANs showed that a high percentage of WLANs are not secured in Jordan. The researcher proposed changing WLAN default settings and well-crafted password Service Set Identifier (SSID) masking as some measures aimed at improving the security of the wireless network by the users.

Another susceptibility in WLAN is observed in its deployment in the Internet of things [42]. The study shows that WLAN technologies for the Internet of Things (IoT), such as IEEE 802.11ah, are vulnerable to major security risks due to their limited computational and memory capabilities, thus limiting the implementation of durable intrusion defence and security protocols. They opined that security administrators must conduct regular and extensive vulnerability evaluations of IoT devices to address this issue.

Wireless networks have grown in popularity as a means of Internet connection in Bangladesh. There is, however, a dearth of statistics on the inherent vulnerability and harm that underlie the use of WLAN. Hossain et al. [43] describe a pilot study in a university context in which they examined the current scenario regarding its vulnerability to malicious attacks. They demonstrated that a substantial number of wireless access points can be exploited and that users can be exploited with evil twin attacks using custom-built portable wireless penetration testing equipment. They maintained that the routers configured in their default state are easy targets for attack; and that the users’ lack of awareness drives them to visit vulnerable websites. As a result, public awareness can help mitigate network threats. The users in the examined areas mostly use social media sites over public Wi-Fi and may fall prey to social engineering if unaware.

Based on the study, individuals with technical competence are more concerned with the safety.

This study conducted by the authors in [44] assesses the security of wireless networks in Nuku'alofa's CBD with considerable results. They maintained that Wireless networks had grown rapidly since their inception, maintaining that wireless equipment's security protocols have achieved a robust level. However, security is still an issue, and this study seeks to address security concerns with these questions: How has wireless network growth and security fared? And how can there be an improvement in wireless network security in Tonga. The Nuku'alofa wardrive results clearly showed the number of commercial and home networks. The study is designed using an exploratory research approach. The data revealed a considerable increase in WLAN usage when the fibre optic network was implemented. However, this study concludes that Nuku'alofa WLAN security is still evolving.

The high points of WLANs include speed, range, usefulness, and ease of use, and security is a big concern [45]. The work in [46] in their research aims to highlight the security and privacy concerns of Internet users in Malaysia by exposing the vulnerabilities of Kampung Wi-Fi networks, wardriving with open-source software. The work in [47] addresses the primary risks to WLAN security and some of the various solutions for blocking or limiting illegal access. They submit that WLAN's security strategy must consider the number of possible clients, the value of the data, the likelihood of attacks, and the cost of protective measures as a holistic approach to the WLAN security. The evaluation of WLAN density within a geographical location is a critical step in developing realistic models for the deployment structure of a security framework to mitigate attacks [48]. Such densities are often obtained by large-scale wardriving-like measuring campaigns using off-the-shelf devices as a security approach to WLAN.

The work of [49] examined a database of over 5 million wireless access points obtained by Skyhook Wireless through Wardriving. The result of the analyzed data shows that default naming was a common practice. They also discovered that AP data could provide fertile ground for understanding the intended use of Wi-Fi access points when combined with the location information. It was also observed that analysis and mining of this massive and expanding repository of AP data have the potential to deliver significant technical, social, economic, and security benefits. Additionally, the work demonstrates how geographic information may be used to better understand the overall wireless infrastructure by examining network features such as access point density, demographic biases, and signal propagation behaviour [49].

Data acquired by wardriving in Leeds, UK, revealed a statistically significant influence on Wi-Fi security by ISPs and substantial disparities between several distinct Internet Service Providers (ISPs). Although WEP is a cryptographically flawed encryption mechanism, some networks were discovered to be using it, and identifiable ISPs gave these routers. They are in a position to maintain track of out-of-date routers. The researchers feel that this emphasizes the need for router upgrades and have several recommendations for ISPs, router

manufacturers, and end users. The duty-of-care issue was raised: ISPs are held liable for their customers' Wi-Fi security when they provide routers with wireless access points. ISPs frequently advertise that they provide secure networks, and home users are unlikely to reconfigure their routers [50].

The work presented in [51] focuses on mechanisms for cost-effectively collecting data from several devices for developing social, economic, and security architectures. At a relatively low cost, data collected by opportunistic Wardriving can provide current Wi-Fi deployment data in communities around the Philippines. Much information on APs may be acquired, including encryption, providers, kinds, and even density. The data collected may be used to guide a variety of decisions on Internet accessibility and other related helpful initiatives.

Constant access to the Internet is now a daily routine. The covid19 scare exacerbated the use of WLAN for the Internet in virtually all aspects of human endeavours, especially in education, governance, entertainment, etc. Despite these, security concerns are not emphasized with deserving urgency and seriousness. A degraded and obsolete WEP protocol is still in use. The work in [52] focused their study on the WEP protocol in a sector of the city of Bogota, Columbia. The authors observed that using cheap WLAN devices from Oriental companies dominates the IT market. These low-cost devices operate under low-security standards. The authors submitted that there was a need for improved security culture in WLANs.

The studies of [53] reveal that many residences are installing wireless access points without considering their security. It is expected that more digital crime cases will be launched as a result of this. It also looks into forensic technologies monitoring war drivers. Open and unauthorized APs may be set up as honeypots. A wireless honeypot can disclose important information regarding infrastructure assaults, such as attack frequency, attacker's skill, plan, and methodology [54]. Researchers have adopted several techniques to arrive at research goals in dealing with WLAN security, as stipulated in Table 1.

3. Research Method

Our comprehensive evaluation of the literature was prompted by [73]. A systematic literature evaluation was conducted to thoroughly and concretely address the specified concerns. A thorough analysis was conducted based on collected research, and the most pertinent studies addressing the specified issues were reported. The entire purpose of this review is to assemble the most relevant materials from primary sources. These publications were analyzed and assessed to obtain the most accurate findings. The primary goal of a systematic review is to design an unbiased technique [74]. We made the same efforts to eliminate any element of bias to achieve objectivity. As seen in Figure 2, our review design comprises a sequence of phases. The sequential processes in the review methodology are as follows: establishing research questions, developing a strategy for search, documenting the strategy, establishing criteria for inclusion and exclusion, criteria for quality assessment, and

TABLE 1: Related work categorization by techniques.

| Year | Ref. no. | Research method/ technique | Domain | Description |
|------|----------|----------------------------|--------------------------------|--|
| 2021 | [55] | Security model | Wireless network | Analyses a new physical layer security strategy to improve wireless communication security against eavesdroppers |
| 2020 | [56] | Security model | Wi-fi network security | Proposes a model for small and medium-sized businesses by identifying and analyzing security measures in businesses |
| 2018 | [57] | Empirical analysis | Wireless network | Employs empirical data to map wi-fi hotspots in metropolitan areas to operationalize the virtual component of urban vibrancy |
| 2019 | [58] | Survey | Wi-fi security | Describes the fundamentals of wi-fi security problems to raise awareness |
| 2014 | [59] | Experimental procedure | Network security | Uses a correlation coefficient-based learning method to find problems in WLAN |
| 2014 | [60] | Review | Wi-fi security | Considers the remote security threats to current wireless systems and standards, including WEP, WPA, and WPA 2. (WPA2). |
| 2021 | [4] | Review | Wi-fi security | Enables visualizing the numerous factors required in wi-fi wireless network security |
| 2018 | [51] | Wardriving | Wi-fi | Assists in comprehending a low-cost technique for acquiring information about wi-fi distribution in a variety of locations |
| 2021 | [61] | Wardriving | Wi-fi security | Proposes a standalone python-based programme for assessing the vulnerability of wardriving-captured access points (APs) |
| 2021 | [62] | Penetration testing | Wi-fi security | Presents a kAli linux-based wi-fi penetration testing technique |
| 2021 | [63] | Wardriving | Wi-fi security | Analyses the results of evaluating the security of a wireless network on raspberry pi running kAli linux |
| 2021 | [36] | Survey | Wi-fi security | Examines the possibilities for integrity, availability, and confidentiality and also analyses most WLAN packet services and technologies, revealing safety |
| 2020 | [64] | War-flying | Cyber security | Designs a system for using a drone to capture and map unauthorized 2.4 GHz and 5 GHz wireless network access points in mission-critical infrastructure, then converting the data to a map view |
| 2019 | [65] | Survey | Network security | Highlights the prospective risk and forms of network security attacks, as well as shedding light on existing preventative approaches and making realistic ideas for their enhancement |
| 2019 | [66] | Wardriving | Wi-fi security | Provides a method for identifying rouge access points based on a set of static properties chosen from a well-conducted experiment on real-world locations |
| 2018 | [67] | Multi-parameter framework | WLAN security | Improves rouge access point detection in WLAN by using a multi-parameter-based approach |
| 2021 | [68] | War flying | WLAN security | Evaluate wireless networks drone system (warflying) that detects and analyses information such as access point locations, MAC, authentication, power, privacy, and encryption settings |
| 2020 | [69] | Survey | Wi-fi network security | Examines wireless technologies and the security vulnerabilities that these technologies offer to larger communication networks |
| 2017 | [70] | Survey | Wi-fi security | Focuses on developing solutions for mitigating cyber-attacks and examines the hazards associated with utilizing wireless devices to offer Internet service in open access zones |
| 2021 | [71] | Review | Wireless network security | Explores the worldwide implications of growing wireless network technologies and cyber security concerns and suggests some recommended remedies |
| 2021 | [72] | Wi-fi protocol model | Wi-fi security | Provides a model for detecting wi-fi protocol attacks with low false positives and varied low rates of false negatives for various attacks |
| 2021 | [61] | Analysis tool | Wireless access point security | A python language-based tool is proposed and implemented as a standalone tool for assessing an access Point's vulnerability |

quantitative meta-data analysis. The stages are explained in further detail in the next section.

This effort aims to find, assess, and synthesize significant academic material on WLAN security utilizing Wardriving methodologies. Despite the topic's real-world relevance, there is a shortage of academic research, particularly on a widely agreed-upon, comprehensive definition of wardriving WLANs to determine their security posture. This problem makes it difficult for academics and organizations to locate pertinent literature, impeding study and innovation in this sector. We intend to offer a guided tour of the available literature and build a shared ground truth. We also

adhere to Tranfield et al.'s [75]. The three-stage approach is based on well-established criteria [76, 77]. Their review methodology details the research topics, sources of information, search criteria, and pertinent keywords. Following the initial collection of articles, we use established criteria for inclusion and exclusion to trim down publications in terms of quantity and improve the quality of the literature chosen for future assessment.

3.1. Research Questions. The literature evaluation aims to develop questions that potentially include security and offer

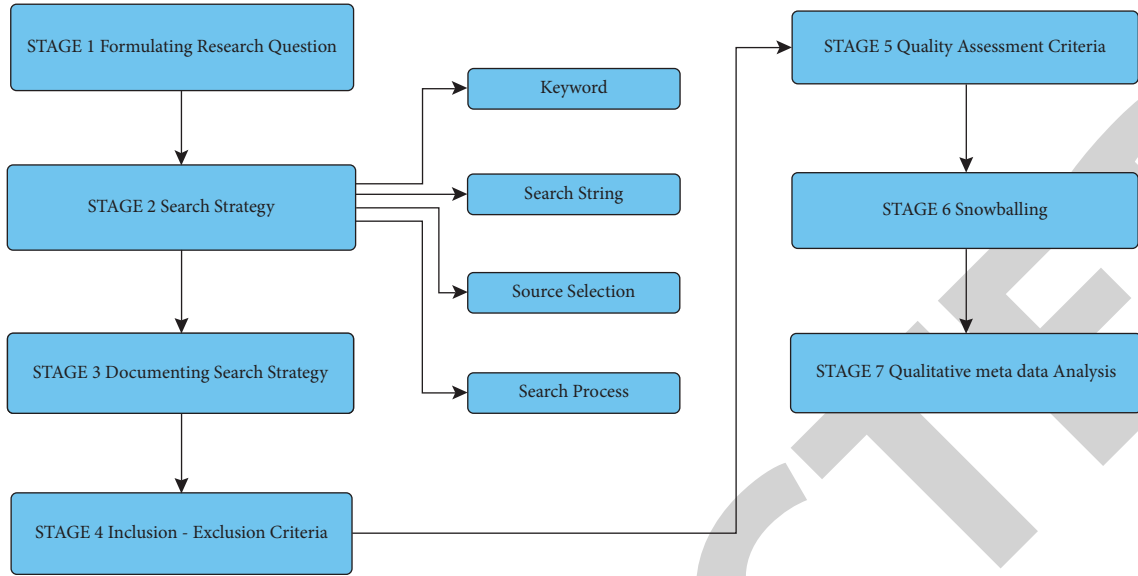


FIGURE 2: Systematic literature review model.

TABLE 2: Research questions.

| Research questions | Motivation |
|--|--|
| (1). What are the security challenges associated with wireless local area network (WLAN)? | The focus is on how to gain deep insight into the security challenges and concerns of WLAN |
| (2). How is the wardriving method considered a technique for evaluating WLAN security? | This question aims to provide the security posture of WLAN of a location using wardriving techniques |
| (3). How do the present security measures and mechanisms improve security in WLAN infrastructures? | A comparative analysis of WLAN security mechanisms and their impact |
| (4). What are other measures deployed to enhance WLAN security? | The main focus is to outline other security measures to enhance WLAN security |

tangible solutions to those concerns. The study's research topics sparked discussions on possible privacy and security safeguards for WLAN analysis employing Wardriving. Four research questions were created, and our collected studies were used to address them in this research study. Table 2 provides a detailed explanation of the questions posed in this study.

3.2. Search Strategy. We focused on appropriately organizing our search technique using identification, screening, and the Prisma protocol approach [78]. The first stage in the protocol was to use keywords to create a search string. To find articles, keywords alone are insufficient; they must be concatenated in various ways to generate a string containing the names of many journals and digital libraries [79]. The work in [80] was the source of our search approach. The search technique consisted of four steps: keyword identification, search string, source selection, and search execution.

3.3. Defining Keywords. In order to obtain the most relevant results from articles, keywords were specified for a particular query [81]. Table 3 provides a list of all the different terms that have been used for searching. The primary topic's search string was created by combining the keywords from

each inquiry. Additionally, formulated questions were searched using keywords to get information about the subject.

3.4. Search String Strategy. A search string was built using precise query terms. This was confirmed by computer security and wireless networking specialists. The search query was tested on many search engines and adjusted until it yielded the most relevant results. The model presented by [82] was adopted to create search strings.

- Major words derived from subject and research questions
- Identifying alternate spellings or synonyms for main nouns
- Identifying relevant keywords
- By using the Boolean operator OR to find the synonyms or other spellings
- The relationship between main phrases and the Boolean AND operator

Consequent to the above method, the following search strings were generated.

("Security Protection" OR "Safety") AND ("Wi-Fi Network" OR "WLAN") AND ("Wardriving" OR "OTM

TABLE 3: Research Questions associated with keywords.

| Research question | Keywords |
|---|--|
| RQ1. What security issues exist in wireless local area network (WLAN)? | “Security challenges” OR “security problems” AND “wireless local area network” OR “WLAN” OR “wi-fi” |
| RQ2. How is the wardriving method considered a technique for evaluating WLAN security? | “Wireless local area network” OR “WLAN” OR “wi-fi” AND “security mechanisms” OR “security protocols” OR “security measures” AND “wardriving” OR “warwalking” |
| RQ3. How do the present security measures and mechanisms improve security in WLAN infrastructures? What are the shortcomings of wardriving? | “Security procedures” OR “security techniques” OR “security model” AND “wireless local area network” OR “WLAN” OR “wi-fi” AND “wardriving” OR “warwalking” AND “shortcomings” OR “limitations” |
| RQ4. What are other measures deployed to enhance WLAN security, such as hard and soft wares? | “Hardware” AND “softwares” AND “wardriving” OR “warwalking” AND “wireless local area network” OR “WLAN” OR “wi-fi” |

TABLE 4: Data sources.

| Data Source | Website address |
|----------------|--|
| Scopus | Scopus-advanced search signed in |
| IEEE | IEEE xplore: advanced search |
| Hindawi | Search hindawi |
| Web of science | Advanced search-web of science core collection |

TABLE 5: Inclusion and exclusion details.

| Name of journal | Inclusion | Exclusion | Total |
|-----------------|-----------|-----------|---------|
| Hindawi | 1,483 | 6,296 | 7,779 |
| Scopus | 32 | 1,147 | 1179 |
| IEEE | 103 | 46,613 | 46,716 |
| Web of science | 9 | 23,179 | 23,188s |

Scanning”) AND (“Assessment” OR “Evaluation” OR “Analysis”).

A systematic pilot search was performed to provide the best possible results and to fine-tune the search technique. Our search phrase is divided into two sections: the first Section discusses WLAN security, while the second Section discusses the Wardriving technique.

3.5. Sources Selection. In order to gather data, the following libraries and databases were utilized. Many areas of our topic are covered in these libraries, making them the most useful. These libraries’ search engines are better ideal for automated searches since they are user-friendly and powerful [83]. Table 4 contains a list of these databases and libraries.

3.6. Search Process. Our search took place from December 2021 to January 2022. Primary studies were found using automated and manual searches. According to [82], automatic research is superior to manual research. However, a manual search was conducted to ensure the search string was correct. The search string was used on all databases specified in Table 4. This search generated 7,779 results on Hindawi, 1,179 results from Scopus, 46,716 results from IEEE Xplore, and 23,188 results from the Web of Science.

3.7. Search Strategy Documentation. The documentation of our search approach was influenced by [84]. This phase involved the creation of a paper outlining our search approach in detail. The number of included and excluded papers was carefully documented, and the details are presented in Table 5. Additionally, data regarding the search method used to retrieve records based on the given search phrase were recorded, such as the search date, the name of the online library, and the number of items retrieved. This stage generates a report including all pertinent information

regarding the search method. With the documentation provided, it is easier to evaluate a search and maintain tabs on the progress of that search.

3.8. The Criteria for Inclusion and Exclusion of Articles. Table 6 explains the specifics of the criteria for Eligibility and Non-Eligibility of articles. The articles included in the study were evaluated using the following inclusion and exclusion criteria. Duplicate papers were deleted in the first attempt, and articles were then evaluated against the stated keywords and study objectives. The articles that were dropped did not give thorough replies to the questions. Then, using inclusion-exclusion criteria, each paper was evaluated based on its title, abstract, and entire text. Studies were chosen for inclusion from peer-reviewed journals. When many versions of the same document exist, the most recent, complete, and an updated copy is chosen for inclusion, and the others are eliminated. Conflict analysis was used to eliminate bias at every level of the selection process.

3.9. Criteria for Quality Assessment. For every research, the quality evaluation criteria are critical. Following the study selection, we used quality evaluation in our research. The goal of this approach is to enhance the selection criteria. The quality assessment questions (QAs) checklist was developed. Each publication was verified against the checklist to pick the most related research, the majority of which would answer our RQs. The work presented in [85] served as the foundation for the quality evaluation approach. “Yes” was allotted to an article that met the quality assessment checklist and a “No” if it did not meet all of the quality evaluation criteria. Some research articles were discovered that only partially answered the QA questions. To that end, each research article was awarded a score or value based on how well it answered the quality assessment questions. For each question, the options are “Yes,” “No,” and “Partial,” with

TABLE 6: The criteria for inclusion and exclusion of articles.

| |
|---|
| Included articles |
| Included were English-language research articles |
| Original articles were selected |
| Range of research papers in years from 2010 to 2022 |
| Excluded articles |
| Non-English research articles are excluded |
| Articles that did not address or capture the research questions were excluded |
| Duplicate articles were not counted |

scoring set at 1, 0, and 0.5, respectively. There are only three possible answers. Each manuscript was assessed against the QA questions, and a quality total was computed for each research paper at the conclusion. Table 7 contains a checklist of quality evaluation questions. The initial stage was to establish QA questions, and then a scale was created to award ranks to the papers based on the QA questions checklist. The aggregate value (AV) was calculated by adding all weights granted based on QA questions. An AV of at least 2.5 was required for an article to be accepted for publication, and the work was rejected if it was below 2.5. Figure 3 illustrates the process of quality evaluation.

3.10. Snowballing. Snowballing is crucial for research since it leads to additional investigation [82]. Both forms of snowballing, forward and backwards snowballing, were used in our study to get the most relevant results.

3.11. Analysis of Quantitative Meta-Data. Our evaluation is contingent upon the analysis of quantitative meta-data since it provides statistical data analysis from research papers. Additionally, literature on quantitative meta-analysis frequently advocates developing criteria for studying quality when making inclusion decisions [86]. In order to completely grasp our research issue, this study analyses data from several perspectives.

4. Research Questions on the Selected Studies

This Section answers the research questions in depth to achieve the goals of the research questions.

4.1. Rq1: What Are Security Challenges Associated with WLAN? WLANs use radio waves to transmit and receive data. WLANs are subject to illegal interception, eavesdropping, hacking, and various other cyber security threats because of the lack of a physical barrier.

The following are the three most prevalent WLAN security threats:

- (1) Denial of service attack, in which an intruder floods the network with messages, causing network resources to become unavailable.
- (2) Spoofing and session hijacking - when an attacker assumes the identity of a legitimate user to obtain access to network data and resources.

TABLE 7: Quality assessment questions.

| Question ID | Quality assessment question |
|-------------|---|
| QA1 | Are the research's goals and objectives properly stated? |
| QA2 | Is the security of WLAN using wardriving stated? |
| QA3 | Are any solutions provided for the formulated RQs |
| QA4 | Does it answer to the security of WLAN in the light of wardriving? |
| QA5 | Did the security techniques related to WLAN and wardriving contribute to this work? |

- (3) Eavesdropping is when data is intercepted while sent over a secure network by an unauthorized third party.

WLAN hardware employs a variety of security techniques, including:

- (1) Service Set Identifiers (SSIDs) block devices from connecting to access points unless they use the right identification.
- (2) Media Access Control (MAC) restricts access to access points by employing addresses assigned to each device.
- (3) WEP-WPA Encryption - These ensure that only devices with the right key can interact with access points. These security standards differ in the level of protection based on the authentication mechanism and encryption techniques used [87].

Basic WLAN characteristics cannot ensure security even when all of these security measures are implemented. Furthermore, security features on WLAN devices are frequently turned off. If the default stage is not modified, no security is provided.

4.2. Rq2: How Is the Wardriving Method Considered a Technique for Evaluating WLAN Security? Wardriving is a passive wireless network scanning technique intended to acquire statistical data about wireless networks to help mobile computing and network security [35].

On the other hand, Wardriving is going about a given geographical region and scanning wireless network devices [88]. Today, Wardriving includes Bluetooth and ZigBee, widely used in IoT and smart devices. Warwalking, warbiking, and warflying with drones are examples of network scanning [8].

A survey system and process are the two components that constitute an effective wardriving exercise. The system is commonly built around open-source operating systems (Linux and Android). Others are open-source applications and commercially available hardware, while the survey is conducted using the passive scanning approach.

The network SSIDs, the Wireless Access Points (WAP), MAC, Manufacturers' names, Utilized channel, Encryption technique used, and the projected network location may all be derived from the gathered data. With this information, it

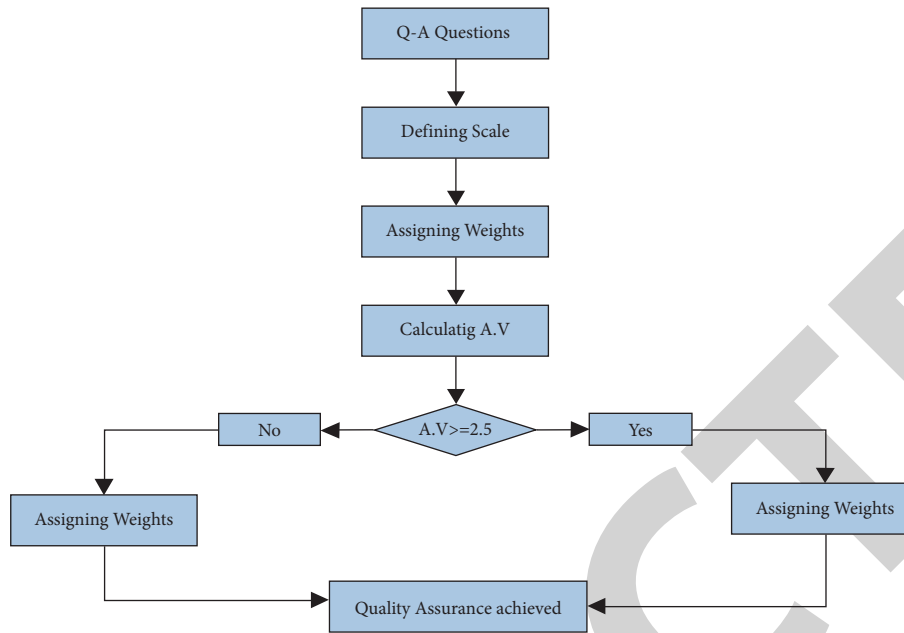


FIGURE 3: Flow chart of quality assessment.

is possible to establish the current condition of WLAN security in a region being studied.

4.3. Rq3: How Do the Present Security Measures and Mechanisms Improve Security in WLAN Infrastructures? What Are the Shortcomings of Wardriving?

- (a) **Default Passwords Modification:** Preconfigured default administrator passwords are standard on most network equipment, including wireless access points. Because of their simplicity, these default passwords offer just a minimal level of protection. Changing the default password on a computer can make it more secure [89]. Passwords should be complex and changed frequently to protect WLAN data.
- (b) **Limited Access to Network Resources:** Allow only authorized users to connect to a network. A media access control (MAC) address is assigned to each piece of network hardware. Unauthorized users may be restricted access to network resources [90]. The “guest” account, a common feature found on many wireless routers, is a restrictive option when activated. This feature allows visitors Wi-Fi access on a second wireless channel with a different password while keeping the primary credentials private.
- (c) **Data protection by encryption:** By encrypting wireless data, anyone who has access to the network will be unable to access it. A variety of encryption techniques can provide this security. The Wi-Fi Protected Access (WPA), WPA2, and WPA3 protocols encrypt data sent between wireless routers and devices [91]. WPA3 is the most secure encryption available right now. Although WPA and

WPA2 are still available, it is recommended that the equipment that supports WPA3 is used, as utilizing the previous protocols may expose the network to exploitation.

- (d) **Cloaking Service Set Identifier (SSID):** Avoid making the SSID public to prevent unauthorized access to the network. Users may secure their device’s SSID on all Wi-Fi routers, making it more difficult for attackers to locate a network [92]. Change SSID to something unique at the very least. When the SSID default option is enabled, a prospective attacker can determine the kind of router and exploit any known vulnerabilities.

4.4. Rq4: What Are Other Measures Deployed to Enhance WLAN Security, Such as Hard and Soft Wares? Other measures that enhance WLAN security include

- (1) **Setting up a firewall.** Consider firewalls on wireless devices (a host-based firewall) and networks (a router- or modem-based firewall); an attacker who gets direct access to the wireless network may bypass the network firewall. On the other hand, a host-based firewall adds another layer of security to a computer’s data [93].
- (2) **Virtual private network (VPN):** VPNs can safeguard wireless networks. Most WAPs can pass VPN traffic. Normally, the wireless network is segregated from the rest of the network, and all access is via the VPN server. Ideally, a business should put Access Points with VPN servers on them. An access point with its VPN server can be isolated. This AP connects directly to the WLAN. Only clients using VPN software and the right credentials will be given access.

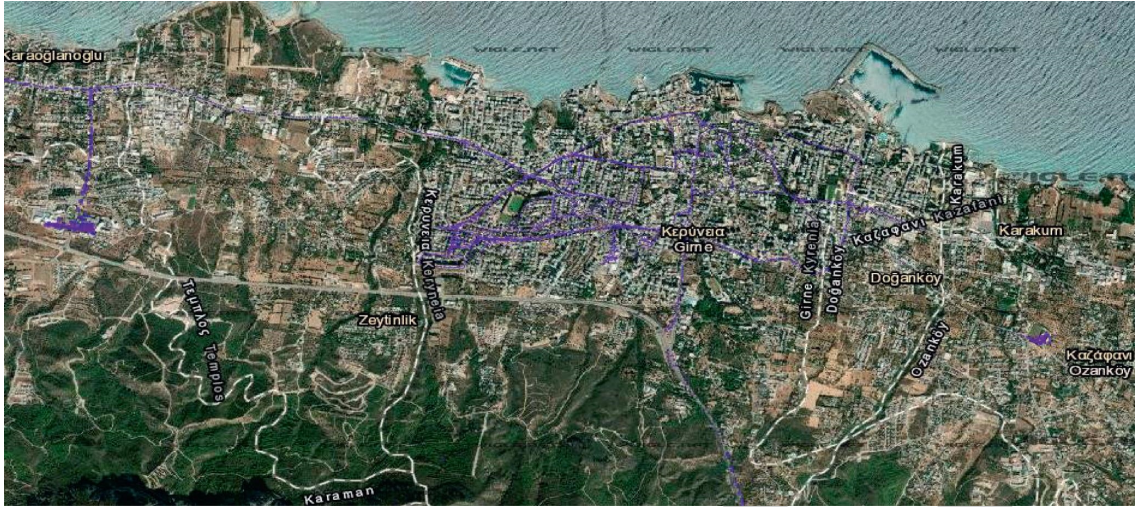


FIGURE 4: High-density Wi-Fi locations in Girne.

The WLAN connections cannot be sniffed since all traffic is encrypted [94].

- (3) Maintaining up-to-date antivirus software and ensuring that Access points or Router firmware are updated are additional measures to protect WLAN [95].
- (4) Network file sharing and device file sharing should be disabled. Never enable file sharing on public networks [96].
- (5) The Wi-Fi Protected Setup (WPS) encryption simplifies the process of accessing the wireless network by requiring the user to input a PIN or use the Push Button Configuration (PBC), often referred to as Quick Secure Setup (QSS) [97]. Because of the inherent vulnerability of WPS-enabled access points, it is better to disable WPS in preference to WPA2 or the latest security mechanisms.

5. A Test Case Scenario of Wardriving Technique

5.1. Background. In order to underscore the effectiveness of wardriving as a technique for gauging the availability and security status of Wi-Fi networks at given geolocations, a measurement campaign was performed in November and December 2021 and January 2022. The experiment was conducted in designated locations in the mid-sized city of Girne (Kyrenia) in the north of Cyprus. Girne is located in the northern hemisphere at coordinates 35.3416667, 33.3166667. The selected places represent typical WLAN usage locations, namely, Academic, City centre and a major route across the city, as depicted in Figure 4. The analyzed result of the systematic measurement campaign provided an estimate of the density of WLAN and a general overview of its availability while also giving insight into the security mechanisms in use. The survey aims to determine how widespread the usage of antiquated and outdated encryption methods and newer encryption mechanisms are deployed in

the area under review. Observing other WLAN security practices also enabled us to determine the present condition of WLAN security in Cyprus. The process is depicted in Figure 5.

5.2. Data Acquisition. The data gathering instrument was the Wireless Geolocation Engine (Wigle) Android application [98], developed for use on smart devices. A Samsung Model SM-N960F device with an internal WNIC and a GPS receiver was used for the survey. This work offers an opportunistic Wardriving approach, which maximizes using already available assets at the lowest potential cost. Wardriving sessions were performed in November, December 2021 and January 2022 around High-density Wi-Fi locations in Girne, as shown in Figure 5.

Before analyzing the findings of the WLAN survey, the obtained data must be processed. Depending on the survey tool, this can be done in numerous ways. For example, the Wigle programme handles the sample automatically. Wigle outputs the.kml and the.csv file formats (Keyhole Mark-up Language and Comma Separated Value, respectively). The.kml files can be visualized in Google Earth or Map, as depicted in Figure 5, while the.csv file can be visualized in any spreadsheet application and Pandas data frame, as seen in the spreadsheet in Figure 6.

5.3. Survey Results. It is important to note that the views of [99–103] about various connectivity issues can affect the density and the overall evaluation of a wardriving result based on the variability of several issues highlighted in this paper. The wardriving approach is used in this work to crawl wider regions for examination [104–106]. A passive investigation was conducted, with security findings drawn only from publicly accessible information emitted by each wireless access point [107]. In order to produce statistical reports, data is processed and statistically analyzed. Channel usage, SSID security, the Encryption type (Open, WEP,

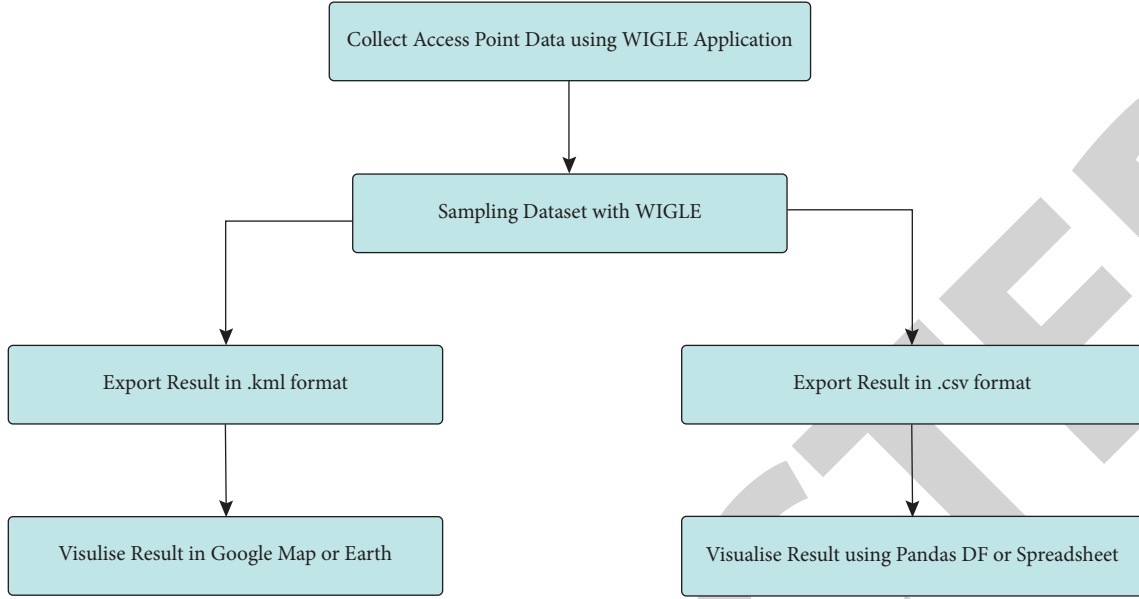


FIGURE 5: Wardriving process.

| | MAC | SSID | LAT | LON | AUTH | DATES | Channel | RSSI | ALT | ACCUR | TYPE |
|-------|-------------------|-----------------|-------------|-------------|--------------------|--------------------|---------|------|---------|-------|------|
| 1 | a2f6caci2c2d:fef | GAUWIFI | 35.33210517 | 33.27657948 | [ESS][PARTIAL] | 2021-11-05 14:1... | 1 | -74 | 79.4562 | 192 | WIFI |
| 2 | d8:0f:99:15:d5:c8 | LAPTOP-8C851... | 35.33210517 | 33.27657948 | [WPA2-PSK-CCM... | 2021-11-05 14:1... | 11 | -74 | 79.4562 | 192 | WIFI |
| 3 | 50:d4:f7:47:03:f0 | BIMAH | 35.33210517 | 33.27657948 | [WPA2-PSK-TKIP+... | 2021-11-05 14:1... | 6 | -80 | 79.4562 | 192 | WIFI |
| 4 | 34:e8:94:44:dd:6a | KaderFatih | 35.33210517 | 33.27657948 | [WPA2-PSK-TKIP+... | 2021-11-05 14:1... | 11 | -91 | 79.4562 | 192 | WIFI |
| 5 | d6:ca:6d:06:28:7b | HIDDEN SSID | 35.33197035 | 33.27668131 | [ESS] | 2021-11-05 14:1... | 161 | -86 | 45.4765 | 96 | WIFI |
| 6 | d4:ca:6d:06:28:7b | AyComK39EYH... | 35.33197035 | 33.27668131 | [ESS] | 2021-11-05 14:1... | 161 | -87 | 45.4765 | 96 | WIFI |
| 7 | d4:ca:6d:e8:02:45 | AyComK39EYH... | 35.33197035 | 33.27668131 | [ESS] | 2021-11-05 14:1... | 132 | -87 | 45.4765 | 96 | WIFI |
| 8 | d6:ca:6d:e8:02:45 | HIDDEN SSID | 35.33197035 | 33.27668131 | [ESS] | 2021-11-05 14:1... | 132 | -89 | 45.4765 | 96 | WIFI |
| 9 | 7a:0c:b8:a1:e6:22 | LAPTOP-8C851... | 35.33195388 | 33.27669848 | [WPA2-PSK-CCM... | 2021-11-05 14:1... | 11 | -56 | 46.6666 | 400 | WIFI |
| 10 | a2f6caci2c2d:fef | ALJABAH | 35.33195388 | 33.27669848 | [WPA2-PSK-CCM... | 2021-11-05 14:1... | 11 | -83 | 46.6666 | 400 | WIFI |
| 11 | 4e5e0c31:9f:cd | GAUWIFI | 35.33214693 | 33.27682595 | [ESS] | 2021-11-05 14:1... | 36 | -89 | 66.7206 | 32 | WIFI |
| 12 | 4c5e0c31:9f:cd | HIDDEN SSID | 35.33224929 | 33.27683628 | [ESS] | 2021-11-05 14:1... | 56 | -90 | 69.073 | 16 | WIFI |
| 13 | 9a6ecf57:f2:e5 | AyComK39EYH... | 35.33224929 | 33.27683628 | [ESS] | 2021-11-05 14:2... | 56 | -87 | 70.2835 | 16 | WIFI |
| 14 | fa:f9:07:5f:18:66 | iPhone | 35.33224929 | 33.27683628 | [WPA2-PSK-CCM... | 2021-11-05 14:2... | 6 | -54 | 71.1694 | 12 | WIFI |
| 15 | 98:da:c4:e0:50:e4 | GAUWIFI | 35.33224271 | 33.27689317 | [ESS][PARTIAL] | 2021-11-05 14:2... | 1 | -61 | 72.7644 | 16 | WIFI |
| 16 | c8:3a:35:57:0d:48 | iPhone | 35.33234039 | 33.27694752 | [WPA2-PSK-CCM... | 2021-11-05 14:2... | 6 | -90 | 73.3688 | 16 | WIFI |
| 17 | 9c9d:7e:6e:64:8b | iPhone | 35.33234943 | 33.2769431 | [WPA2-PSK-CCM... | 2021-11-05 14:2... | 6 | -84 | 72.765 | 12 | WIFI |
| 18 | 64:09:acce:47:af | AyComK39EYH... | 35.33235503 | 33.27692364 | [ESS] | 2021-11-05 14:2... | 132 | -81 | 71.4166 | 16 | WIFI |
| 19 | d6:ca:6d:ac:8e:a1 | HI | 35.33235503 | 33.27692364 | [ESS] | 2021-11-05 14:2... | 132 | -81 | 71.4166 | 16 | WIFI |
| 20 | ac:84:c6:15:d6:46 | AyComK39EYH... | 35.33235503 | 33.27692364 | [ESS] | 2021-11-05 14:2... | 161 | -82 | 71.4166 | 16 | WIFI |
| 21341 | c8:3a:35:2d:b3:d8 | Tibet | 35.33684667 | 33.31461584 | [WPA-PSK-CC... | 2021-11-11 12:1... | 6 | -81 | 76.4279 | 4 | WIFI |
| 21342 | 7a:28:f1:89:7d:20 | OLD HOLBORN | 35.33684667 | 33.31461584 | [WPA2-PSK-CC... | 2021-11-11 12:1... | 6 | -85 | 76.4279 | 4 | WIFI |
| 21343 | e2:82:70:f9:e8:c3 | GAZANATION | 35.33684667 | 33.31461584 | [WPA2-PSK-CC... | 2021-11-11 12:1... | 3 | -86 | 76.4279 | 4 | WIFI |
| 21344 | 62:bc:46:0d:56:b5 | B7LSEV | 35.33684667 | 33.31461584 | [WPA2-PSK-CC... | 2021-11-11 12:1... | 11 | -87 | 76.4279 | 4 | WIFI |
| 21345 | a6:2a:a6:05:ca:52 | Boray | 35.33684667 | 33.31461584 | [WPA2-PSK-CC... | 2021-11-11 12:1... | 11 | -88 | 76.4279 | 4 | WIFI |

FIGURE 6: Sample of the captured dataset.

TABLE 8: Summary of encryption type.

| Encryption type | Frequency | Percentage |
|-----------------|-----------|------------|
| OPEN ACCESS | 5,359 | 25.1 |
| WEP | 23 | 0.1 |
| WPA | 18 | 0.08 |
| WPA + WPA2 | 6,793 | 31.83 |
| WPA2 | 9,139 | 42.82 |
| WPA3 | 13 | 0.06 |
| TOTAL | 21,345 | 99.99 |

WPA, WPA2, WPA3, and Mixed-mode), WPS usage statistics, geographical locations, detailed security statistics described in Wigle CSV format, and vendor statistics are

TABLE 9: Open and hidden SSIDs.

| | | |
|--------------|--------|--------|
| Hidden SSIDs | 2,791 | 13.07% |
| Open SSIDs | 18,554 | 86.93% |

summarised in the study. In order to compile vendor statistics, the IEEE MAC address allocation lists are used [108].

About 21,345 WLAN networks were gathered with the related data. We can deduce the network SSIDs, manufacturers, MAC addresses, utilized channels, encryption protocols, and projected network location from the collected data. One may assess the area's WLAN security based on the obtained data. This may be done by analyzing the use of

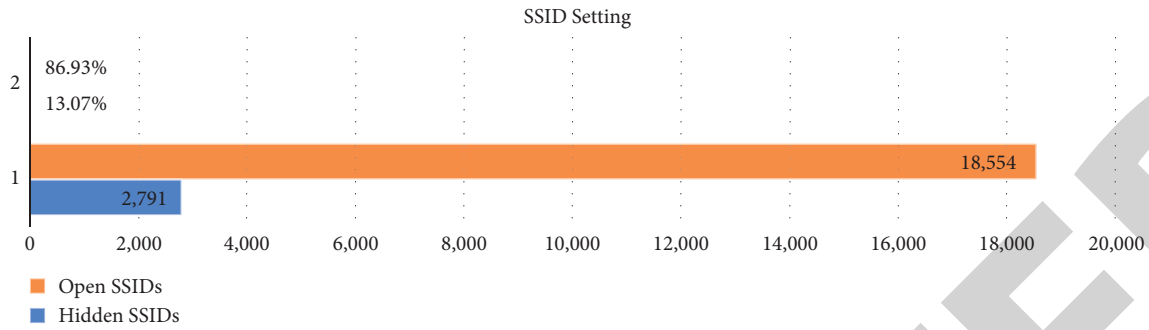


FIGURE 7: Ssid setting.

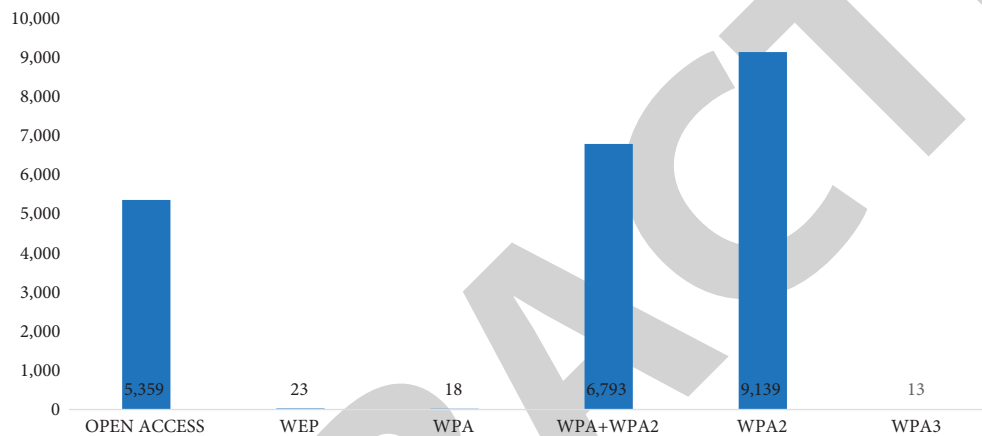


FIGURE 8: Distribution of encryption types.

encryption protocols and other security procedures like cloaking or changing the network SSID and WPS settings. Figure 6 is a sample of the captured WLAN dataset.

Table 8 provides a summary of the analyzed dataset. Guest networks provided by different companies, schools, and other organized establishments in investigated locations may account for some of the high numbers of open, unencrypted networks (5,359, 25.1%). Twenty-three networks used the deprecated WEP, and 18 still utilized the out-of-date WPA-TKIP encryption standard. WPA + WPA2 (mixed mode) accounted for 31.83% of the total networks. This may largely be attributed to legacy access point devices that need support.

Veiled SSID was only seen on 13.07% of the networks analyzed in this study, while Open SSIDs accounted for 86.93%. For this study, veiled networks are referred to as HIDDEN SSIDs, as shown in Table 9 and Figure 7.

On average, 2.36 percent of the surveyed networks had SSIDs that included the device manufacturer, model, or ISP name in digits and letters. The prominent manufacturer is TP-LINK. 73.11% of the studied wireless networks were found to be using the 2.4 GHz band, according to a study on wireless channel utilization. Most networks used the non-overlapping channels 1, 6, and 11 in the 2.4 GHz range. In the 5 GHz spectrum, most networks are set to use channels 36, 52, and 108. Further statistics show that WPS-enabled APs account for 10,329, while non-WPS-enabled APs are 11,016 of 21,345 discovered access points, as shown in

TABLE 10: 2.4GHz nonoverlapping and other channels.

| Channels | Count | Percentage |
|-----------------------|--------|------------|
| Channel 1 | 2,671 | 17.11 |
| Channel 6 | 3,245 | 20.79 |
| Channel 11 | 3,321 | 21.27 |
| Other 2.4GHZ channels | 6,470 | 40.82 |
| Total | 15,607 | 100 |

Table 8 and Figure 8, respectively. Therefore, 11,016 or 51.61% of Wi-Fi networks fall within WEP, WPA, WPA2, WPA3, and Open Access, which are non-WPS enabled. The overall security of the study area is poor, considering that part of the 51.61% still has the deprecated WEP and the fairly secured WPA networks.

In terms of channel usage, the most discovered networks, 15,607 (73.11%), were found on the 2.4 GHz band, and over 59.17% of networks were set to operate on channels 1, 6, and 11. Table 10 shows the 2.4GHz channel used, and Figure 9 depicts the spread of the nonoverlapping channels in the 2.4GHz band.

The intermediate channels between the nonoverlapping channels in the 2.4GHz band (2, 3, 4, 5, 7, 8, 9, 10, 12, and 13) are not often used. However, when an Access Point is set to AUTO Channel, the device hops across channels using any channel with no interference.

The 5.0GHz had 5,738 (27.89%) networks, with channels 36, 52, 120, and 161 as dominant channels, as depicted in Table 11 and Figure 10.

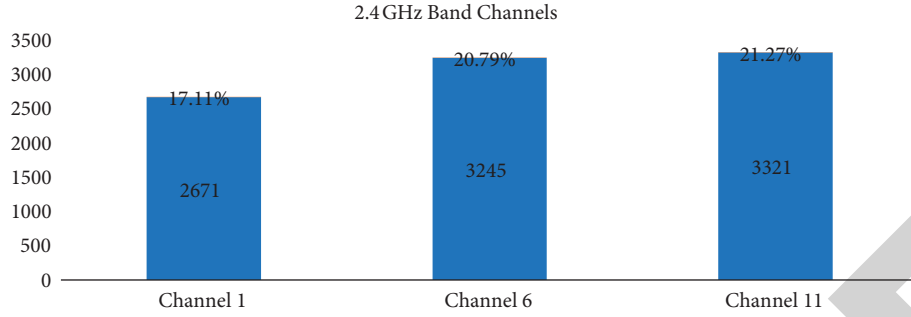


FIGURE 9: 2.4GHz nonoverlapping channels.

TABLE 11: 5 GHz prevalent channels.

| Channels | Count |
|----------------------|-------|
| Channel 36 | 629 |
| Channel 52 | 407 |
| Channel 120 | 347 |
| Channel 161 | 364 |
| Other 5 GHz channels | 3,991 |
| Total | 5,738 |

TABLE 12: WPS result in the surveyed network.

| Security setting | Count | % |
|---------------------|--------|-------|
| WPS-enabled APs | 10,329 | 48.39 |
| Non-enabled WPS APs | 11,016 | 51.61 |

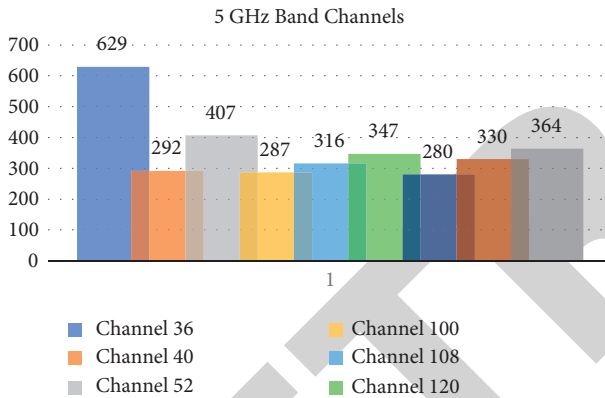


FIGURE 10: Dominant 5GHz channels.

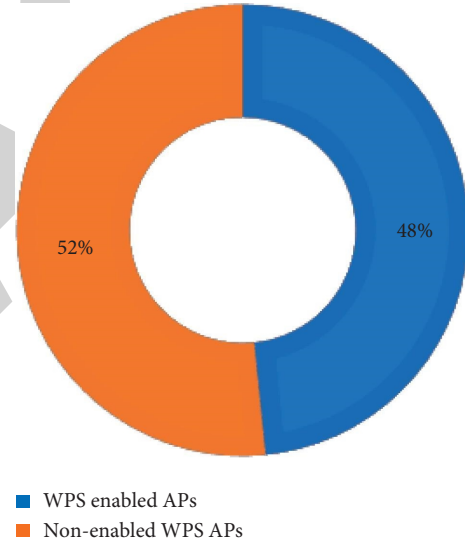


FIGURE 11: WPS settings in the surveyed network.

WPS is an insecure feature that increases the vulnerability of wireless networks to attack. WPS does nothing more than make it easier for clients to connect to Wi-Fi. It is risky for a function that provides such a minor advantage as the convenience of connecting to be enabled in a secured infrastructure. For secure WLAN, WPS are to be disabled [109].

With WPS-enabled networks constituting 48%, as shown in Table 12 and Figure 11, about half the number of WLANs in the study sample are vulnerable and susceptible to attacks.

5.4. Limitations of the Study. Some identified limitations of this survey are summarised as follows:

In the wardriving toolset, we used an Android smart device with an internal antenna for this study instead of a laptop with a high-power external antenna that would have provided wider coverage within the selected locations.

Wardriving with a car limits scanning only along motorable access paths. Future endeavours should consider

war-droning or warflying as a more effective alternative, as a drone will cover wider areas, not limited to motorable roads.

In the wardriving measurement campaign, some captured Wi-Fi networks were not necessarily Home/Office networks; some were Mobile/Ad hoc networks. No known tool can distinguish between Stationary and Mobile/Ad hoc Access Points (MiFi devices). A faulty WLAN density assessment can arise due to two fundamental factors.

- The mobility of Ad hoc devices at each experiment will cause a change in a dataset, and the general inference of the statistical evaluation of the measured geolocation is altered.
- On the other hand, Mobile/Ad hoc depends on mobile phone towers' cellular data to provide wireless Internet connectivity. Because of variable connectivity issues, mobile AP devices (MiFi) may be ON and OFF a wardriving radar, resulting in inconsistent results and datasets at each run.

The views expressed in the works [99–103] on various connectivity issues can affect the density and the overall evaluation of a wardriving result based on the variability of the above problems. However, current research endeavour using Artificial Intelligence (AI) and Machine Learning is addressing these issues [110–113]. Last, it is unclear how the proposed scheme would revolutionize some critical aspects of emerging wireless security systems. Therefore, it would be nice to explore how the projected framework would behave in blockchain-based information security systems [114], unified authentication and access control systems [115], radio frequency identification and password-enabled security access system [116], and localization for the jamming attack in wireless sensor networks [117].

6. Conclusions

The data extracted from WLAN surveys could be used to get insights on WLAN availability, security, and use. The data could subsequently be utilized to provide proposals and procedures to enhance WLAN networking security in a dynamic environment and forecast the future of WLAN security systems. Following the successful survey and data analysis, it can be deduced that the suggested Wardriving technique achieved the stated purpose. It can successfully collect and analyze WLAN security networks with minimal hardware and publicly accessible software. From the 21,345 networks detected, 23 (0.1 percent) used WEP encryption, 18 (0.08 percent) used WPA-TKIP encryption, 5,359 (25.1 percent) were unencrypted, and 9,139 (42.82 percent) used the more secured WPA2 encryption, 13 networks (0.06 percent) used the latest WPA3 encryption technique. From the projected data, it would be rational to infer that WLAN security in North Cyprus is moderate when the encryption mechanisms are considered as the main variable. It is worth mentioning that most unencrypted networks are Open Guest Networks (OGN) supplied by cafés, schools, governments, and other business enterprises. A close examination of the surveyed data reveals that owners of wireless network devices in the tested locations left their wireless networks' factory-set default settings unchanged. About 2.92% of the networks examined utilized recognizable factory-set SSIDs, whereas just 13.07% employed the masked SSIDs. In addition, 15,607 (73.11%) of the studied networks operated on the 2.4 GHz band. Interestingly, 9,237 (59.17%) of the networks operated on channels 1, 6, and 11. Other channels on the 2.4GHz band made up the remaining 6,370 or 40.9%. The 5.0GHz had 5,738 (27.89%) networks, with channels 36, 52, 161, and 120 as dominant. As a result, Wi-Fi access points should have their SSID, channel, and passwords customized from the factory defaults. When devices utilize the default network name (SSID), this may suggest that they also use the default password, which is well known to the suppliers and adversaries. This is a potential point of entry, and in the event that the device's model and manufacturer are revealed in the SSID and default password, an attacker would have all the information needed to initiate an assault on the wireless network. While wireless network scanners can circumvent the benefits of changing the

network SSID, the proposed procedures can help keep casual eavesdroppers at bay and give the wireless network an extra layer of protection. In order to undertake further in-depth research on the evolution of the WLAN landscape, wardriving with newer WNICs and high gain types of antennae and improved survey result accuracy is imperative. Finally, the data analysis process must be enhanced since the amount of WLAN data gathered will grow with time, necessitating more efficient data storage and sampling procedures. Along with studying the evolution of the broader WLAN networking landscape, more detailed research on Wardriving ethics will form part of our future work.

List of Abbreviations

| | |
|---------|--|
| AP: | Access point |
| CIA: | Confidentiality, integrity, and availability |
| GPS: | Global positioning system |
| IEEE: | Institute of electrical and electronics engineers |
| IoT: | Internet of things |
| MAC: | Media access control |
| MESL: | Mobile enterprise security and legal |
| ISP: | Internet service provider |
| OTM: | On-the-move |
| PBC: | Push button configuration |
| QA: | Quality assessment |
| QSS: | Quick secure setup |
| SMB: | Small and medium-sized businesses |
| SOHO: | Small offices and homes |
| SSID: | Service set identifier |
| STRIDE: | Spoofing, tampering, repudiation, information disclosure, denial of service, elevation of privileges |
| USB: | Universal serial bus |
| VPN: | Virtual private network |
| WEP: | Wired equivalent privacy |
| Wi-Fi: | Wireless fidelity |
| WIGLE: | Wireless geolocation engine |
| WLAN: | Wireless local area network |
| WPA: | Wi-Fi protected access |
| WPS: | Wi-Fi protected setup. |

Data Availability

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

Conflicts of Interest

The authors declare no conflict of interest related to this work.

Acknowledgments

The work of Agbotiname Lucky Imoize was supported in part by the Nigerian Petroleum Technology Development Fund (PTDF) and German Academic Exchange Service (DAAD) through the Nigerian–German Postgraduate Program, under Grant 57473408.

References

- [1] C. Kohlios and T. Hayajneh, *A Comprehensive Attack Flow Model and Security Analysis for Wi-Fi and WPA3*, pp. 1–28, MDPI, Basel, Switzerland, 2018.
- [2] W-F Alliance, “Value of wi-fi,” 2022, <https://www.wi-fi.org/discover-wi-fi/value-of-wi-fi>.
- [3] Business Wire, *Smart Home Will Drive Third Wave in Wireless Home Evolution: Strategy Analytics*, 2019, <https://www.businesswire.com/news/home/20190807005530/en/Smart-Home-Drive-Wave-Wireless-Home-Evolution>.
- [4] G. Lorena, B. Cristian, and H. Julio, “Conceptual model of security variables in wi-fi wireless networks: review,” in *Proceedings of the ITNG 2021 18th International Conference on Information Technology-New Generations*, AISC, June 2021.
- [5] A. Hilal, A. Salman, and S. El-Tawab, “Exploring the use of IoT and WiFi-enabled devices to improve fingerprinting in indoor localization,” in *Proceedings of the 2019 IEEE Global Conference on Internet of Things (GCIoT)*, IEEE, Dubai, December 2019.
- [6] H. S. Choi, C. Darrell, and M. S. Ko, *Risk Taking Behaviors Using Public Wi-Fi*, Information Systems Frontiers, 2021.
- [7] R. Kalniņš, J. Puriņš, and G. Alksnis, “Security evaluation of wireless network access points,” *Applied Computer Systems*, vol. 21, no. 1, pp. 38–45, 2017.
- [8] C. Hurley, R. Rogers, F. Thornton, and B. Baker, *WarDriving and Wireless Penetration Testing*, Elsevier Science, 2007.
- [9] H. Valchanov, J. Edikyan, and V. Aleksieva, “A study of wi-fi security in city environment,” in *Proceedings of the IOP Conference Series: Materials Science and Engineering*, IOP, October 2019.
- [10] H. Chris, R. Rogers, F. Thornton, and B. Baker, *Wardriving and Wireless Penetration Testing*, Syngress, Rockland, 2007.
- [11] P. S. Ryan, “War, peace, or stalemate: Wargames, wardialing, wardriving, and the emerging market for hacker ethics,” *Virginia Journal of Law and Technology*, vol. 9, no. 7, pp. 3–57, 2004.
- [12] B. D. Kern, “Whacking, joyriding and war-driving: roaming,” *Santa Clara Computer and High Technology Law Journal*, vol. 21, no. 1, pp. 101–162, 2004.
- [13] C. Meshram, A. Aljaedi, and A. R. Alharbi, “SBOOSP for massive devices in 5G WSNs using conformable chaotic maps,” *Computers, Materials & Continua*, vol. 71, no. 3, pp. 4591–4608, 2022.
- [14] W. Sean, “Be aware of these 7 common wireless network threats,” *Pluralsight*, 2020, <https://www.pluralsight.com/blog/it-ops/wireless-lan-security-threats>.
- [15] C. Hurley, Rogers, and Thornton, *WarDriving and Wireless Penetration Testing*, Syngress, 2007.
- [16] L. Caviglione, “Wireless wardriving,” *Handbook of Research on Wireless Security*, pp. 61–77, 2008.
- [17] S. Webb, *Growth in the Deployment and Security of 802.11b Wireless Local Area Networks in Perth, Western Australia*, pp. 48–56, Edith Cowan University, Perth, 2004.
- [18] S. Yek, *Wily Attackers Seek Wireless Networks in Perth, Western Australia for Easy Targets*, Edith Cowan University, Perth, Western Australia, 2005.
- [19] L. Chih-Ta, S. Hira, and J. Donald, “Wireless network security,” *Unitec New Zealand*, pp. 337–339, 2004.
- [20] L. Wolter, H. Vic, and G. John, *The Innovation Journey of Wi-Fi: The Road to Global Success*, Cambridge University Press, 2010.
- [21] N. I. Sarkar and A. H. Abdullah, “Exploring wireless network security in Auckland City through warwalking field trials,” in *Proceedings of the 13th International Conference on Advanced Communication Technology (ICACT2011)*, IEEE, Gangwon, January 2011.
- [22] A. Sarrafzadeh and H. Sathu, “Wireless LAN security status changes in Auckland CBD: a case study,” in *Proceedings of the IEEE International Conference on Computational Intelligence and Computing Research*, IEEE, Madurai, India, December 2016.
- [23] A. Nisbet, “A tale of four cities: wireless security & growth in New Zealand,” in *Proceedings of the International Conference on Computing, Networking and Communications (ICNC)*, IEEE, Maui, HI, USA, January 2012.
- [24] A. Nisbet, “A 2013 study of wireless network security in New Zealand: are we there yet?” in *Proceedings of the 11th Australian Information Security Management Conference*, Edith Cowan University, Perth, 2013.
- [25] A. Sebbar, S. Boulahya, G. Mezzour, and M. Boulmalf, “An empirical study of WIFI security and performance in Morocco -WarDriving in Rabat,” in *Proceedings of the 2nd International Conference on Electrical and Information Technologies ICEIT'2016*, IEEE, May 2016.
- [26] Z. Akram, M. A. Saeed, and M. Daud, “Wardriving and its application in combating terrorism,” in *Proceedings of the 2018 1st International Conference on Computer Applications & Information Security (ICCAIS)*, IEEE, Riyadh, Saudi Arabia, April 2018.
- [27] H. A. Noman, S. A. Noman, and Q. Al-Maatouk, “Wireless security in Malaysia: a survey paper,” *Journal of Critical Reviews*, vol. 7, no. 4, pp. 301–312, 2020.
- [28] M. Maráci, “Wardriving in eger,” in *Proceedings of the IEEE 13th International Symposium on Applied Computational Intelligence and Informatics*, pp. 127–130, IEEE, Timisoara, Romania, May 2019.
- [29] P. Bajjal, N. Raj Singh, and P. Singh, “Analysis of current WI-FI security practices via war driving and proposed solution,” *International Journal of Advanced Computational Engineering and Networking*, ISSN, vol. 2, no. 7, pp. 45–49, 2014.
- [30] E. Nasr, M. Jalloul, J. Bachalaany, and R. Maalouly, “Wi-fi network vulnerability analysis and risk assessment in Lebanon,” in *Proceedings of the International Conference of Engineering Risk*, Beirut, May 2019.
- [31] C. Priya, S. Umar, and T. Sirisha, “The impact of war driving on wireless networks,” *IJCSET*, vol. 3, no. 6, pp. 230–235, 2013.
- [32] E. Eldaw, A. M. Zeki, and S. Senan, “Analysis of wardriving activity and WiFi access points,” *Communications in Computer and Information Science*, vol. 366, pp. 51–59, 2013.
- [33] F. Santos, P. Pesantes, and S. Bonilla-Bedoya, “Exploring wardriving potential in the Ecuadorian Amazon for indirect data collection,” in *Proceedings of the 2020 International Symposium on Water, Ecology and Environment - Earth and Environmental Science*, Quito, Ecuador, 2021.
- [34] S. Lindroos, A. Hakkala, and S. Virtanen, “A systematic methodology for continuous WLAN abundance and security analysis,” *Computer Networks*, vol. 197, p. 108359, 2021.
- [35] O. Edward, K. Julius, P. Thibault, and C. Jon, “Wi-fi wardriving studies must account for important statistical issues,” *IEEE*, pp. 1–11, 2020.
- [36] O. H. Anayo, O. C. kelechi, A. I. Yinka, and E. Godwin, “Security in wireless local area network,” *Journal of*

- Multidisciplinary Engineering Science and Technology (JMEST)*, vol. 8, no. 7, pp. 14291–14295, 2021.
- [37] S. Lindroos, *Developing a Systematic Process for Mobile Surveying and Analysis of WLAN Security*, UNIVERSITY OF TURKU, Turku, 2020.
 - [38] S. Domien, R. Aanjhan, and V. Mathy, “Let numbers tell the tale: measuring security trends in wi-fi networks and best practices,” in *Proceedings of the Conference on Security and Privacy in Wireless and Mobile Networks (WiSec '21)*, ACM, New York, June 2021.
 - [39] S. Benqdara and A. Mahmoud, “Wireless security in Libya: a survey paper,” *International Journal of Computer Applications*, vol. 181, no. 35, pp. 26–31, 2019.
 - [40] E. Lawrence and J. Lawrence, “Threats to the mobile enterprise: jurisprudence analysis of wardriving and warchalking,” in *Proceedings of the INTERNATIONAL CONFERENCE ON INFORMATION TECHNOLOGY: CODING AND COMPUTING*, IEEE, Las Vegas, NV, USA, April 2004.
 - [41] A. S. Mashhour and Z. Saleh, “Wireless networks security in Jordan: a field study,” *International journal of Network Security & Its Applications*, vol. 5, no. 4, pp. 43–52, 2013.
 - [42] S. Verma, Y. Kawamoto, and N. Kato, “A network-aware internet-wide scan for security maximization of IPv6-enabled WLAN IoT devices,” *IEEE Internet of Things Journal*, vol. 8, no. 10, pp. 8411–8422, 2021.
 - [43] I. Hossain, M. M. Hasan, S. F. Hasan, and M. R. Karim, “A study of security awareness in Dhaka city using a portable Wi-Fi pentesting device,” in *Proceedings of the International Conference on Innovation in Engineering and Technology (ICIET)*, IEEE, Dhaka, Bangladesh, December 2019.
 - [44] P. R. Lutui, O. Tete’imoana, and G. Maeakafa, “An analysis of personal wireless network security in Tonga: a study of nuku’alofa,” in *Proceedings of the 27th International Telecommunication Networks and Applications Conference (ITNAC)*, IEEE, Melbourne, VIC, Australia, December 2017.
 - [45] P. Shinde, A. Karve, and P. Mandaliya, “Wireless security audit & penetration test using Raspberry pi,” in *Proceedings of the 2018 International Conference on Smart City and Emerging Technology (ICSCET)*, IEEE, Mumbai, India, January 2018.
 - [46] F. Syahrul, N. Akhyari, and S. Nooraida, “Wireless network attack: raising the awareness of Kampung wi-fi residents,” in *Proceedings of the International Conference on Computer & Information Science (ICCIS)*, Kuala Lumpur, Malaysia, June 2012.
 - [47] C. Gherghina and G. Petrică, “Wireless LAN security issues (II). Security assurance,” *International Journal of Information Security and Cybercrime*, vol. 3, no. 1, pp. 37–46, 2014.
 - [48] A. Achtzehn, L. Simi’c, M. Petrova, and P. M’ah’onen, “IEEE 802.11 wi-fi access point density estimation with capture-recapture models communications (CNC),” in *Proceedings of the International Conference on Computing, Networking and Communications (ICNC), Workshop on Computing and Networking*, IEEE, March 2015.
 - [49] K. Jones and L. Liu, “What where Wi: an analysis of millions of wi-fi access points,” in *Proceedings of the 2007 IEEE International Conference on Portable Information Devices*, Orlando, FL, USA, May 2007.
 - [50] Z. C. Schreuders and A. M. Bhat, “Not all ISPs equally secure home users: an empirical study comparing wi-fi security provided by UK ISPs,” in *Proceedings of the 2013 International Conference on Security and Cryptography (SECRYPT)*, Reykjavik, Iceland, July 2013.
 - [51] A. Bandong, C. Felizardo, F. Cedric Angelo, and W. M. Tan, “Opportunistic wardriving through neighborhood public utility vehicles as an alternative to crowdsourcing and dedicated wardriving for wireless network data collection,” in *Proceedings of the IEEE International Conference on Internet of Things and Intelligence System (IoTIS)*, IEEE, Bali, Indonesia, November 2018.
 - [52] F. Valle and M. Alonso, “Identification of patterns in the use of wired equivalent privacy (wep) as a security protocol in wi-fi networks,” *Research Square*, pp. 1–18, 2022.
 - [53] M. G. Huwida Said and I. A. A. Noora Al Mutawa, “Forensics and war-driving on unsecured wireless network,” in *Proceedings of the 6th International Conference on Internet Technology and Secured Transactions*, Abu Dhabi, United Arab Emirates, December 2011.
 - [54] K. Vyas, A. Sharma, and D. Songara, “The growing phenomenon of wireless crime forensic a tracing and tracing,” *International Journal of Computational Engineering Research*, vol. 2, no. 1, pp. 150–156, 2012.
 - [55] S. K. M. Ataelmanan and M. A. H. Ali, “Develop an effective security model to protect wireless network,” *IJCSNS International Journal of Computer Science and Network Security*, vol. 21, no. 3, pp. 48–54, 2021.
 - [56] D. Vega, A. Lozano, F. Blanco, and F. Simanca, “Model for the implementation of security in wi-fi networks for SMEs,” *Journal of Physics: Conference Series*, vol. 1828, no. 1, p. 012105, 2021.
 - [57] K. Young-Long, “Seoul’s Wi-Fi hotspots: Wi-Fi access points as an indicator of urban vitality,” *Computers, Environment and Urban Systems*, pp. 1–12, 2018.
 - [58] E. Ahmet and K. Mesrur Betül, “Wi-fi security analysis for E&M-Government applications,” *International Journal of Multidisciplinary Studies and Innovative Technologies*, vol. 3, no. 2, pp. 86–98, 2019.
 - [59] P. Kavitha and M. Usha, “Anomaly based intrusion detection in WLAN using discrimination algorithm combined with naïve bayesian classifier,” *Journal of Theoretical and Applied Information Technology*, vol. 62, no. 1, pp. 77–84, 2014.
 - [60] U. Kumar and S. Gambhir, “A literature review of security threats to wireless networks,” *International Journal of Future Generation Communication and Networking*, vol. 7, no. 4, pp. 25–34, 2014.
 - [61] A. M. Thomas, G. A. Kumaran, R. Ramaguru, R. Harish, and K. Praveen, “Evaluation of wireless access point security and best practices for mitigation,” in *Proceedings of the 2021 5th International Conference on Electrical, Electronics, Communication, Computer Technologies and Optimization Techniques (ICEECCOT)*, Mysuru, India, December 2021.
 - [62] H. J. Lu and Y. Yu, “Research on WiFi penetration testing with Kali Linux,” *Complexity*, vol. 2021, pp. 1–8, 2021.
 - [63] D. Delija, Ž. Petrović, G. Sirovatka, and M. Žagar, “An analysis of wireless network security test results provided by Raspberry pi devices on Kali Linux,” in *Proceedings of the 2021 44th International Convention on Information, Communication and Electronic Technology (MIPRO)*, IEEE, Opatija, Croatia, September 2021.
 - [64] B. Sándor, “Warflying – 2.4 ghz and 5 ghz wireless network detection by drone in critical infrastructure,” *Cybersecurity-Review*, pp. 1–11, 2020.
 - [65] N. N. Shree, K. Kamesh, S. Vishwa, R. Ravikumar, and R. Hegde, “Security challenges in mobile communication networks,” in *Proceedings of the 2019 Third International Conference on Inventive Systems and Control (ICISC)*, Coimbatore, India, January 2019.

- [66] F. Tchakounte, M. Nakoe, B. O. Yenke, and K. P. Udagepola, "Recognizing illegitimate access points based on static features: a case study in a campus wifi network," *International Journal of Cyber-Security and Digital Forensics*, vol. 8, no. 4, pp. 279–291, 2019.
- [67] S. B. Vanjale and P. B. Mane, "Multi parameter based robust and efficient Rogue AP detection approach," *Wireless Personal Communications*, vol. 98, no. 1, pp. 139–156, 2018.
- [68] M. Taneja, S. Bhiwapurkar, N. Mohanty, and B. Bhattacharyya, "Vulnerability analysis and testing of wireless networks through warstorming," in *Proceedings of the 2021 International Conference on Advances in Computing and Communications (ICACC)*, IEEE, Kochi, Kakkannad, India, October 2021.
- [69] J. M. Kizza, "Security in wireless networks and devices texts in Computer Science," in *Guide to Computer Network Security*, pp. 399–428, Springer, 2020.
- [70] D. I. Quirumbay, I. A. Coronel, M. M. Bayas et al., "Threats and risks to information security: a practical analysis of free access wireless networks," in *Proceedings of the SPIE 10445, Photonics Applications in Astronomy, Communications, Industry, and High Energy Physics Experiments*, SPIE, August 2017.
- [71] O. J. Adinya, B. I. Ele, and I. O. Obono, "The impact of emerging wireless network system And cybersecurity in a global community," *iJournals: International Journal of Software & Hardware Research in Engineering (IJSHRE)*, vol. 9, no. 3, pp. 53–65, 2021.
- [72] P. Satam and S. Hariri, "WIDS: an anomaly based intrusion detection system for wi-fi (IEEE 802.11) protocol," *IEEE TRANSACTIONS ON NETWORK AND SERVICE MANAGEMENT*, vol. 18, no. 1, pp. 1077–1091, 2021.
- [73] B. Liao, Y. Ali, S. He, and H. U. Khan, "Security analysis of IoT devices by using mobile computing: a systematic literature review," *IEEE Access*, vol. 8, pp. 120331–120350, 2020.
- [74] S. Nazir, S. Shahzad, and N. Mukhtar, "Software birthmark design and estimation: a systematic literature review," *Arabian Journal for Science and Engineering*, vol. 44, no. 4, pp. 3905–3927, 2019.
- [75] D. Tranfield, D. Denyer, and P. Smart, "Towards a methodology for developing evidence-informed management knowledge by means of systematic review," *British Journal of Management*, vol. 14, no. 3, pp. 207–222, 2003.
- [76] W. Jane and R. T. Watson, "Analyzing the past to prepare for the future: writing a literature review," *Management Information Systems Research Center, University of*, vol. 26, no. 2, pp. 8–18, 2002.
- [77] O. Chitu, "A guide to conducting a standalone systematic literature review," *Communications of the Association for Information Systems*, vol. 37, no. 43, pp. 879–910, 2015.
- [78] Prisma, "Prisma TRANSPARENT REPORTING of SYSTematic REVIEWS and META-ANALYSES," 2021, <http://prisma-statement.org/PRISMAStatement/FlowDiagram.aspx>.
- [79] P. Brereton, B. A. Kitchenham, D. Budgen, M. Turner, and M. Khalil, "Lessons from applying the systematic literature review process within the software engineering domain," *Journal of Systems and Software*, vol. 80, no. 4, pp. 571–583, 2007.
- [80] P. Achimugu, A. Selamat, R. Ibrahim, and M. N. Mahrin, "A systematic literature review of software requirements prioritization research," *Information and Software Technology*, vol. 56, no. 6, pp. 568–585, 2014.
- [81] E. M. Grames, A. N. Stillman, M. W. Tingley, and C. S. Elphick, "An automated approach to identifying search terms for systematic reviews using keyword co-occurrence networks," *Methods in Ecology and Evolution*, vol. 10, no. 10, pp. 1645–1654, 2019.
- [82] C. Wohlin, "Guidelines for snowballing in systematic literature studies and a replication in software engineering," in *Proceedings of the 18th International Conference on Evaluation and Assessment in Software Engineering*, ACM, London, England, May 2014.
- [83] S. Mahdavi-Hezavehi, V. H. S. Durelli, D. Weyns, and P. Avgeriou, "A systematic literature review on methods that handle multiple quality attributes in architecture-based self-adaptive systems," *Information and Software Technology*, vol. 90, pp. 1–26, 2017.
- [84] A. K. Kable, J. Pich, and S. E. Maslin-Prothero, "A structured approach to documenting a search strategy for publication: a 12 step guideline for authors," *Nurse Education Today*, vol. 32, no. 8, pp. 878–886, 2012.
- [85] B. Kitchenham and S. Charters, "Guidelines for performing systematic literature reviews in software engineering," Tech. Rep, EBSE–2007–01, Elsevier, pp. 1–57, Durham, UK, 2007.
- [86] J. M. Norris and L. Ortega, "Effectiveness of L2 instruction: a research synthesis and quantitative meta-analysis," *Language Learning*, vol. 50, no. 3, pp. 417–528, 2000.
- [87] I. Shadeed Al-Mejibli and D. N. Rasheed Alharbe, "Analyzing and evaluating the security standards in wireless network: a review study," *Iraqi Journal for Computers and Informatics*, vol. 46, no. 1, pp. 32–39, 2020.
- [88] S. Ekhtator, *Evaluating Kismet and NetStumbler as Network Security Tools & Solutions*, Digitala Vetenskapliga Arkivet, M.S. thesis, 2018.
- [89] A. A.-G. Hezam and K. Dimitri, "A comprehensive study of security and privacy guidelines, threats, and countermeasures: an IoT perspective," *A Journal of sensor and acuator networks*, vol. 8, no. 22, pp. 1–38, 2019.
- [90] J.-K. Kim, W.-J. Lee, C.-B. Chae, and J.-H. Kim, "Performance analysis of fair medium access control protocol for asymmetric full duplex in WLAN," *IEEE Access*, vol. 8, pp. 140546–140557, 2020.
- [91] E. Baray and N. K. Ojha, "WLAN security protocols and WPA3 security approach measurement through aircrack-ng technique," in *Proceedings of the Fifth International Conference on Computing Methodologies and Communication*, IEEE, Erode, India, April 2021.
- [92] K. Juhász, V. Póser, and M. Kozlovsky, "Wi-Fi vulnerability caused by SSID forgery in the IEEE 802.11 protocol," in *Proceedings of the IEEE 17th World Symposium on Applied Machine Intelligence and Informatics*, IEEE, Herlany, Slovakia, January 2019.
- [93] K. S. V. Susmita and D. P. Kailas, "Portable firewall for data security toward secured communication," *East African Scholars Journal of Engineering and Computer Sciences*, vol. 4, pp. 41–45, 2021.
- [94] VARinsights, "WLAN security: 802.1x vs. VPNs," 2021, <https://www.varinsights.com/doc/wlan-security-8021x-vs-vpns-0001>.
- [95] J. Jaejin and I. Y. Jung, "Sustainable and practical firmware upgrade for wireless access point using password-based authentication," *Sustainability*, vol. 8, no. 9, pp. 1–17, 2016.
- [96] A. Imoize, B. Ben-Adeola, and J. Adebisi, "Development of a multifactor-security-protocol system using ambient noise synthesis," *ICST Transactions on Security and Safety*, vol. 6, no. 22, p. 163979, 2020.

Retraction

Retracted: Precision Marketing Strategy for Ecotourism Based on Data Mining and User Images

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] X. Chen, Q. Li, F. Zou, D. Wang, T. Li, and M. Hu, "Precision Marketing Strategy for Ecotourism Based on Data Mining and User Images," *Mobile Information Systems*, vol. 2022, Article ID 1104633, 8 pages, 2022.

Research Article

Precision Marketing Strategy for Ecotourism Based on Data Mining and User Images

Xi Chen,¹ Qinjin Li ,¹ Fuxia Zou,¹ Dan Wang,¹ Tao Li,² and Mengyao Hu¹

¹School of Social Development and Management, Hunan Women's University, Changsha 410004, Hunan, China

²Solux College of Architecture and Design, University of South China, Hengyang 421001, Hunan, China

Correspondence should be addressed to Qinjin Li; zfchen@isa.ac.cn

Received 23 April 2022; Revised 12 May 2022; Accepted 17 May 2022; Published 30 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Xi Chen 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 continuous development of ecotourism industry, it has become a common concern in ecotourism industry to utilize the available data to realize the change of ecotourism industry and promote the product development and business expansion of ecotourism industry. To this end, we propose a personalized ecotourism route recommendation (PTIR) algorithm based on the popularity of points of interest (POI) and users' interest preferences. First, we analyze the real historical ecotourism footprints of users, propose a time-based user interest preference, and design a method to calculate the best ecotourism route given the travel time limit, departure point, and end point. Experiments were conducted on a real dataset of the Flickr social networking site, and the results showed that this personalized ecotourism route recommendation algorithm has greatly improved accuracy and recall compared with the traditional algorithm that only considers POI popularity, and the results were visualized through specific experimental cases based on user image clustering.

1. Introduction

With the development of society, the ecotourism industry is strong in the global development, and the industry is ranked first in terms of scale [1–4]. With the improvement of people's consumption level, ecotourism industry has become the spiritual pillar of people's development in life and the pillar industry of China's economy on the road of development; the demand of ecotourism service is expanding; the issue of how the enterprises in ecotourism industry should effectively use the existing data to develop, expand, and innovate their ecotourism products has become the common concern of each ecotourism. This issue has become a common concern for all ecotourism companies [5–8].

Due to the precision of precision marketing, it is easier to clarify the target customers, so the marketing effect is more obvious, and marketing costs will be reduced. A significant advantage of precision marketing is controllability, because the audience is accurate, so companies can track their research and adjust their marketing strategies through the feedback, so as to achieve better marketing results. The

characteristics of precision marketing are mainly in the following aspects: firstly, effective market segmentation, secondly, targeting customers, thirdly, target customer interaction, and fourthly, increasing customer value [9, 10]. In this paper, we propose the precise marketing of ecotourism constructed in the way of user image and realize the user segmentation by user clustering algorithm; secondly, we realize the personalized recommendation algorithm of ecotourism attractions by feasibility experiment method.

Before recommending an ecotourism itinerary, people want to know which POIs are of interest, and generally this can be regarded as POI recommendation. The system takes into account five factors: weather, time of day, day of the week, user's location, and user's emotion to personalize user's interest preferences, and evaluates a generalized matrix decomposition of the scoring prediction model to recommend POIs that satisfy user's interest preferences [10]. By analyzing the semantic, temporal, and spatial check-in data of users, a probabilistic generation model, i.e., the Topic-Region Model (TRM), is proposed. This model solves the problem of sparse data and recommends the top-k POI

sets for users considering their interests and spatial movement patterns. Paper [11] proposed an active recommendation system based on a context-aware model, which predicts a score for each POI in terms of user interest preferences and different contextual factors (e.g., time required to visit two POIs, POI tour time, weather, user availability, and user's historical ecotourism footprint) and thus recommends POIs suitable for the current context for the target user.

Developing products and expanding business has become a common concern in the ecotourism industry. To this end, we propose a personalized ecotourism route recommendation (PTIR) algorithm based on POI popularity and user interest preferences. The results show that an optimal ecotourism route calculation method is designed given travel time constraints, departure, and destination points, and the results are visualized by a specific experimental case based on user image clustering. The accuracy and recall of this personalized ecotourism route recommendation algorithm are improved compared with the traditional algorithm that only considers POI popularity.

2. Related Work

Ecotourism route recommendation is to plan one or more reasonable ecotourism routes for users that meet their interests and expectations. In recent years, a large number of studies on ecotourism route recommendation have emerged. Paper [12] analyzed ecotourism photos shared by users on social networking sites to recommend ecotourism routes. Paper [13] used the tags and titles in the photo data to obtain the frequent visit pattern of different ecotourism theme categories. The Markov and theme models are combined to propose a probabilistic behavioral model to obtain the probability of a user's visit to the next attraction under the theme and find the top-k ecotourism routes that satisfy the user's interests and time constraints; paper [14] proposes a Bayesian learning model using user-contributed community photos to recommend personalized ecotourism routes for users based on their characteristics (e.g., gender, age, race) and their group ecotourism styles (e.g., family, friends, couples). Although these early studies have successfully used users' shared ecotourism photos to recommend routes for users, [15] did not consider user interests or POI types, and [6, 8] modeled user interests with a theme model but did not consider users' tour starting and ending points.

Among various ecotourism route recommendation algorithms, the route recommendation algorithm based on the orientation problem has been very widely used. Literature [16] is one of the early studies on ecotourism route recommendation based on the orientation problem, which recommends routes for users to maximize the target score when the starting POI and ending POI are known; [17] recommends the best ecotourism route that satisfies both user interest and POI type to users under the travel constraints (e.g., time budget, starting and ending locations); [18] improves the orientation problem using POI types, so that the recommended routes are limited by the order of POI

type access (e.g., art gallery-park-church); [19] combines the POI type access with the POI type access order (e.g., art gallery-park-church). With [17] combining the user's chosen destination and input requirements (e.g., departure date, expected time spent, starting location, and ending location), we use multiobjective criterion functions and other optimization methods to find the activities that meet the user's requirements and constraints and generate ecotourism routes that are closest to the expected time spent, have the shortest ecotourism time, and have the highest activity value and recommend these routes to the user.

Compared with the above work, the ecotourism route recommendation studied in this paper mainly uses the user's access time to a certain type of POI to obtain time-based user interest and uses the orientation problem to return an optimal ecotourism route for the user under the comprehensive consideration of user interest preference and POI popularity.

3. Ecotourism Route Recommendation Method

3.1. Recommended Framework for Ecotourism Routes. As shown in Figure 1, the user based on the orientation problem is using our proposed PTIR algorithm that integrates the user's interest preference and POI popularity.

3.2. Construction of POI Association Diagram. The construction of POI association graph is carried out offline; in this paper, the POIs in the ecotourism sequence of all users are used as nodes in the graph, representing ecotourism locations, and the successive visits of users in the ecotourism sequence generate the edges in the graph.

In this paper, the POI prevalence is calculated as follows:

$$\text{Popular}(p) = \frac{N(p)}{N_{\max}}, \quad (1)$$

where $N(p)$ denotes the number of photos taken by all users in POI_p ; N_{\max} denotes the maximum number of photos taken by users in all similar POIs.

3.3. User Interest Preferences. In this paper, the average visit time for any user at POI_p is denoted by $\bar{V}(p)$ in the ecotourism route recommendation. The average visit time required for each POI_p is given by the following equation:

$$\bar{V}(p) = \frac{1}{n} \sum_{u \in U} \sum_{p_x \in S_u} (t_{p_x}^d - t_{p_x}^a) \sigma(p_x = p); \quad \forall p \in P, \quad (2)$$

where U denotes all users; n denotes the number of users in U who visited p :

$$\sigma(p_x = p) = \begin{cases} 1, & p_x = p \\ 0, & \end{cases}, \quad (3)$$

calculated by the following equation:

$$\text{Int}(u, c) = \sum_{p_x \in S_u} \frac{(t_{p_x}^d - t_{p_x}^a)}{\bar{V}(p_x)} \sigma(\text{Cat}_{p_x} = c); \quad \forall c \in C, \quad (4)$$

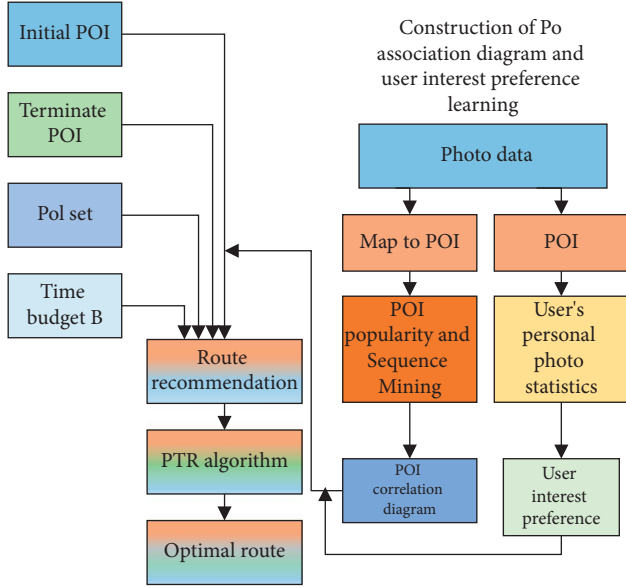


FIGURE 1: Route recommendation framework.

where Cat_p represents the category attribute of POI_p :

$$\sigma(Cat_{p_x} = c) = \begin{cases} 1, & Cat_{p_x} = c \\ 0, & \end{cases} \quad (5)$$

Equation (5) is calculated based on the time spent by the user at each POI with category attribute c .

3.4. PTIR Algorithm. Orientation problem (OP) has been widely used in ecotourism route recommendation. On the basis of orientation problem, this paper proposes a PTIR route recommendation algorithm considering POI popularity as follows:

$$\text{Max} \sum_{i=2}^{N-1} \sum_{j=2}^N x_{i,j} \text{score}(P_i), \quad (6)$$

where $x_{i,j} = 1$ means the route goes from i to j , i.e., via edge (p_i, p_j) ; otherwise $x_{i,j} = 0$.

Equation (6) satisfies the following constraints:

$$\begin{aligned} \sum_{j=2}^N x_{1,j} &= \sum_{i=1}^{N-1} x_{i,N} = 1, \\ \sum_{j=2}^N x_{k,j} &= \sum_{i=1}^{N-1} x_{i,k} \leq 1; \forall k = 2, 3, \dots, N-1, \\ \sum_{i=1}^{N-1} \sum_{j=2}^N \text{Cost}(i, j) x_{i,j} &\leq B2 \leq u_i \leq N, \\ u_i - u_j + 1 &\leq (N-1)(1 - x_{i,j}); \forall i, j = 2, 3, \dots, NPOI_x P_n. \end{aligned} \quad (7)$$

This paper uses the lpsolve linear programming package proposed in [18] to solve the proposed integer programming problem.

3.4.1. Route Planning. To better illustrate the proposed algorithm, given the set of POIs, the information of each POI is shown in Table 1.

There is a user u_1 and the set of POIs he visited Su_1 . The POIs visited by user u_1 and the visit time (i.e., stay time) at each POI are shown in Table 2, and the average visit time at each POI calculated from the user's historical data according to equation (3) is shown in Table 3. The weights of the edges in Figure 2 indicate the time required for a user to u_1 access two POIs consecutively, and the values of the vertices indicate the scores of POIs. p_1 (Central Station) is the starting location, p_2 (Columbia University) is the ending location, and user u_1 's playtime budget is 6 hours; specific parameters are shown in Table 4. Suppose $a = 0.5$. The user's interest preference vector can be calculated from formula (4), then according to the PTIR algorithm, the user's R_3 time budget are obtained, and the three routes are scored by the formula (1), and the score of the route $R_3 = \{p_1, p_4, p_3, p_2\}$ is 0.45; the score for route R_1 is 0.5. The score for route is 0.95. Finally, the route with the highest score u_1 is recommended to user 999, and the route {Central Station, Statue of Liberty, New York Stock Exchange, Columbia University} is recommended to user u_1 .

4. User Image Architecture

In the process of realizing accurate recommendation, companies usually use user image modeling to mine key valuable information such as users' behavioral preferences and interest habits. The core of user image modeling is to refine and organize the user's basic information and behavior information, and this process is to label the user information. The implementation framework of ecotourism user images mainly includes combining the user data about the ecotourism system, obtaining and researching user basic information, user interaction information, user behavior information, classification/clustering analysis, establishing a label system for users, user division, and clustered image presentation of individual users and group users. The implementation framework model of the user image is shown in Figure 3.

In the modeling of user images, it is realized by processing user data through various algorithms. Machine learning algorithm is to process user data to form features of the same dimension and use feature tags to enrich user images. Clustering analysis is also an important algorithm in data mining. In the absence of prior knowledge, data can be divided into different types and aggregated according to the similarity between the data. The similarity of similar elements is high. The segmentation of ecotourism users in this paper is mainly based on clustering algorithm to implement. In addition, data mining also includes a large number of technical and statistical algorithms, such as text retrieval, natural language processing, prediction algorithms, recommendation algorithms, similarity calculation, correlation rules, etc. [20–24].

Ecotourism user images can be divided into two levels: static and dynamic. Static data includes user base and external attributes, and dynamic data includes behavior attribute analysis and purchase consumption attributes, as shown in Figure 4.

TABLE 1: POI category attributes and coordinate information.

| POI | Category properties | Latitude | Longitude |
|-------------------------------|---------------------------------|-----------|------------|
| Central station p_1 | Historical architecture c_3 , | 40.752506 | -73.977477 |
| Columbia university p_2 | University c_2 | 40.807537 | -73.962570 |
| New York stock exchange p_3 | Historical architecture c_3 , | 40.706877 | -74.011265 |
| Statue of liberty p_4 | Sculpture/statue c_1 | 40.689249 | -74.044501 |
| Charging bull p_5 | Sculpture/statue c_1 | 40.705552 | -74.013444 |

TABLE 2: POIs visited by user u_1 .

| POI | Access time/h |
|-------|---------------|
| p_1 | 0.51 |
| p_5 | 0.42 |

TABLE 3: Average access time per POI.

| POI | Average access time/h |
|-------|-----------------------|
| p_1 | 1.1 |
| p_2 | 0.31 |
| p_3 | 0.79 |
| p_4 | 0.81 |
| p_5 | 0.99 |

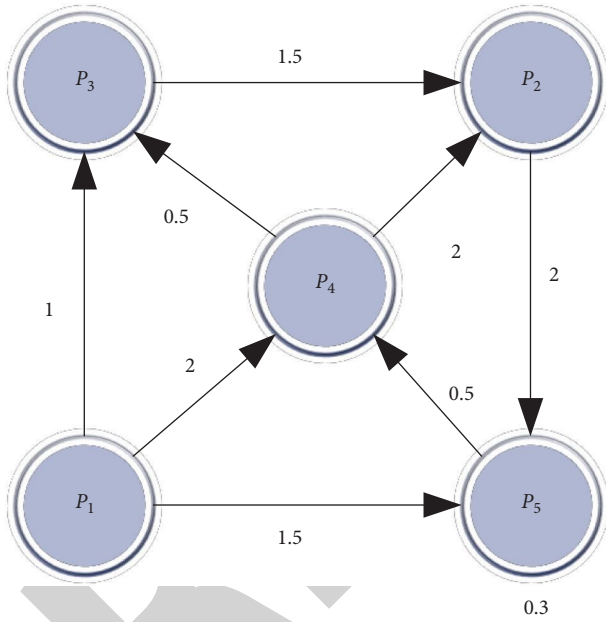


FIGURE 2: An example of route recommendation.

TABLE 4: POI popularity.

| POI | Popularity |
|-------|------------|
| p_1 | 0.21 |
| p_2 | 0.32 |
| p_3 | 0.39 |
| p_4 | 0.59 |
| p_5 | 0.21 |

User image refers to the understanding and visualization of target users in the big data environment. It is a tool for clarifying service goals. Its role is to use big data to fully

interact among users, resources, and services. The ecotourism accurate recommendation system links the relationship between user data and ecotourism product data and fully connects the two types of data. The user image activates the role of traditional ecotourism enterprises in services by predicting the behavior and needs of users and promotes ecotourism enterprises to achieve precision and intelligence. Its functions are shown in Figure 5.

The results of clustering are shown in Figure 6. As the number of clusters increases, the overall silhouette coefficient also increases. When the number of clusters increases to 30, the growth of the silhouette coefficient tends to be stable, and it reaches the inflection point of growth. The clustering relationship in this chapter is determined based on the similarity between users, and the end users with high similarity will be regarded as a class of users with similar feature preferences and will be clustered into one class.

After user clustering algorithm processing and clustering result analysis, users are selected to be divided into 30 categories. It can also be seen from Figure 6 that the effect of clustering discovery is better at this time.

Based on the force-directed layout diagram of the Echarts library, the data visualization of the clustering results was carried out. Echarts provides an intuitive, rich, and highly personalized graphical interface. It is an open-source visualization library based on JavaScript. It has a good display effect and can run smoothly on both PC and mobile based on HTML5.

5. Simulation and Analysis

To measure the performance of the system, metrics such as precision, recall, $F1$ -score, and mean precision (MAP) are used. Table 1 shows the comparison between our method and traditional data mining algorithms such as Apriori, Eclat, decision tree, and logistic regression. It can be seen from Table 5 that all models will decrease the accuracy and increase the recall rate with the increase of the recommendation list, and the model of this paper is better than other methods, achieving 53% $F1$ and 74% MAP, while the worst is the Apriori method that achieves an $F1$ of 48% and a MAP of 58%, with a 16 percentage point difference in MAP between the two.

This study further considers the dimension of the label vector. The test dataset is divided into 6 groups according to the size of the label vector, and each group is evaluated with correspondingly sized itemset proposals. Figure 7 shows the final test results. As can be seen from Figure 7, the method in this paper, logistic regression, and decision tree methods are basically better than the Apriori and Eclat algorithms. The

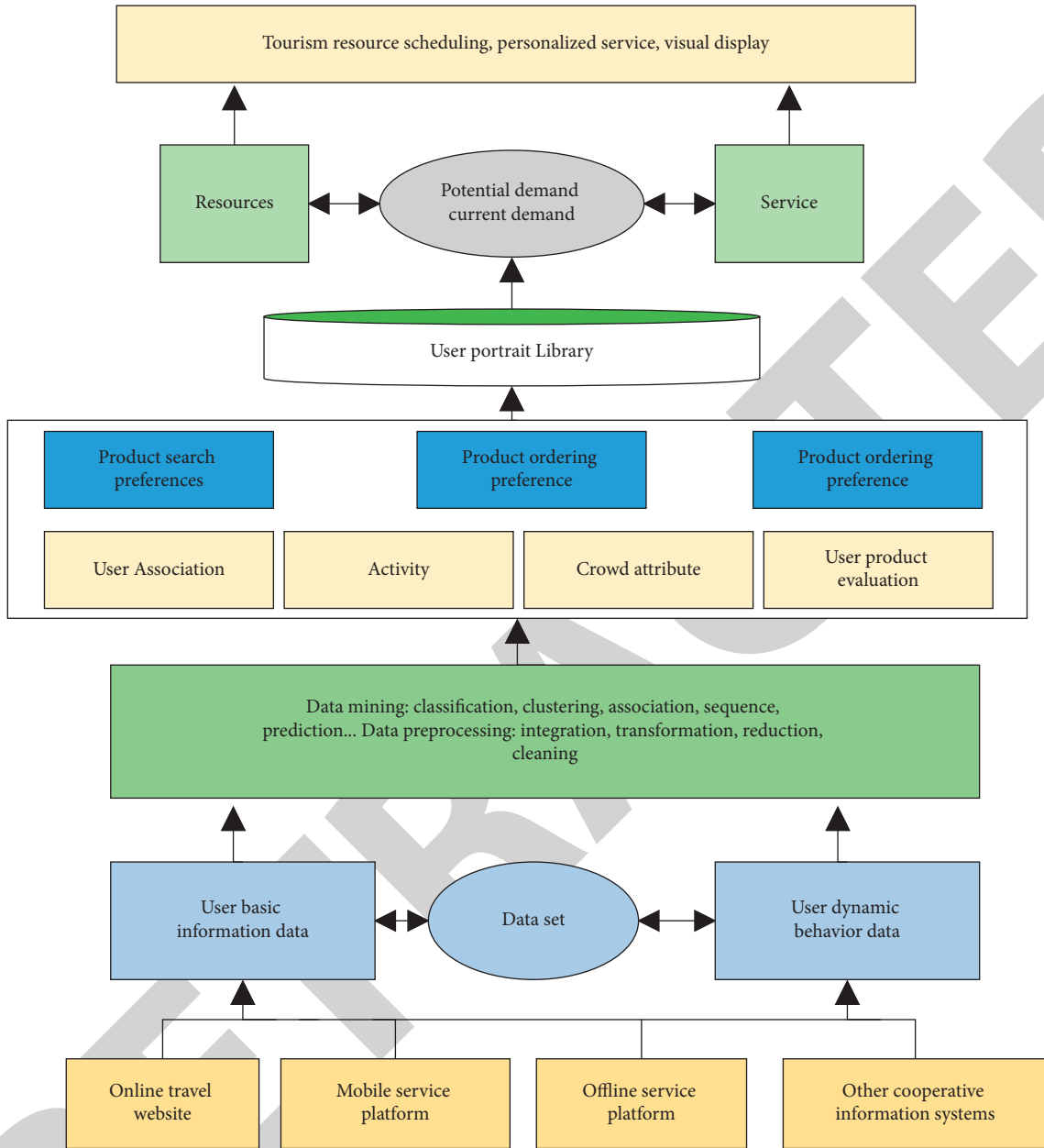


FIGURE 3: Implementation framework model of user image.

final average recommendation accuracy of this method can reach about 80%.

Echarts is driven by data, and data is the basis of graphical representation, so data organization and parameter configuration need to be handled well. For data, there are two main data items nodes and links. Nodes, as a list of node data in the clustering graph, has the following key data item attributes: name attribute, id attribute, value data item value attribute, and layout style attribute. Links is a list of node data relationships in the clustering relationship graph, including two string attributes, source and target, source is the name of the source node of the edge, and target is the name of the target node of the edge. The values attribute of links refers to the value of the edge. In order to make the display more intuitive, this section

expands the user similarity value represented by the edge by 45 times and rounds it up, so that the value of the attribute is represented by the length of the edge. At the same time, configure the layout position and style attributes of links according to the requirements. Since there are 30 types of clusters, in order to avoid confusion and display clearly, a single representative cluster is selected for display. After the data and parameters of the force-oriented layout are configured, the generated force-oriented layout with weights is shown in Figure 8.

When the mouse hovers over a user node in the force-oriented layout diagram, the transparency of other edges and nodes is increased and faded, and the prompt box shows the user attributes of the user of the node and other information. Figure 9 shows the effect when the mouse is hovered over the

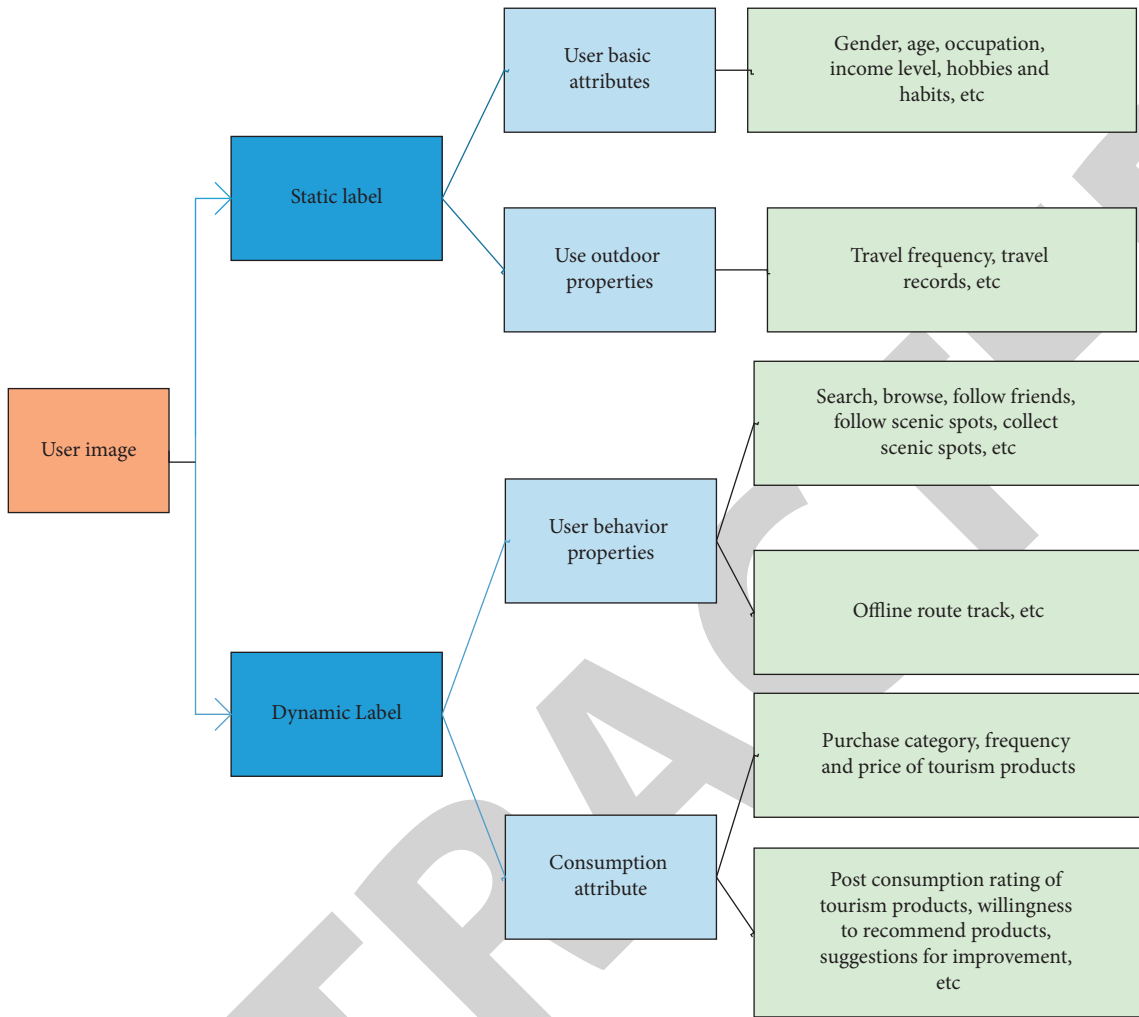


FIGURE 4: Panorama of travel user portraits.

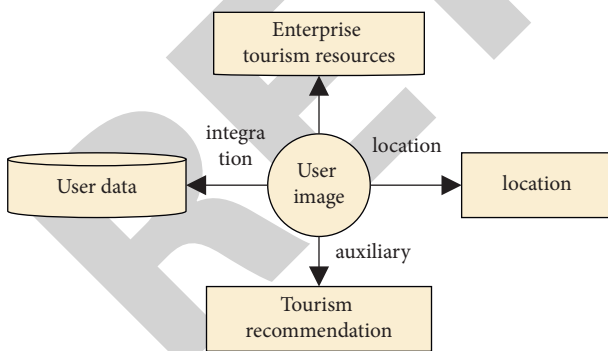


FIGURE 5: User portrait function of travel recommendation system.

user 386. When the mouse is hovered over each connected edge, the edge is bolded and highlighted.

The two associated user nodes are also highlighted, and the prompt box shows the weight information of the edge. The rest of the nodes and connected edges are faded, as shown in Figure 9:

By visualizing the clustering results and observing the hierarchical structure of the user relationship network and

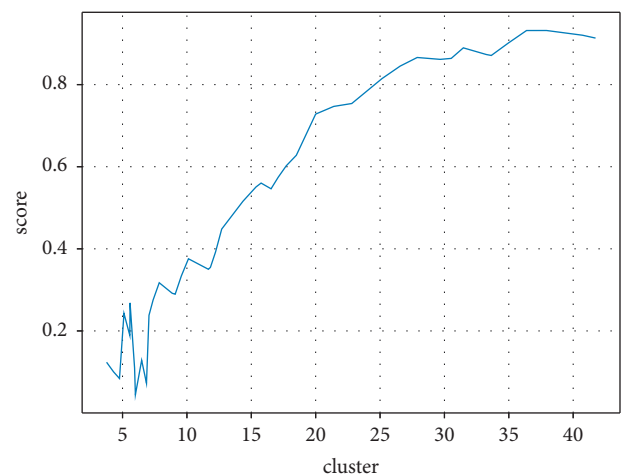


FIGURE 6: Contour coefficient map of clustering results.

the key information of the user network, it can be clearly seen that the user clustering example implemented in this section has divided the users with the same characteristics into classes with distinctive characteristics each. The

TABLE 5: Comparison of network security verification packages (unit: %).

| Method | Accuracy | Recall | F1 score | MAP |
|---------------------|----------|--------|----------|-----|
| Apriori | 41 | 63 | 49 | 59 |
| Eclat | 42 | 63 | 49 | 60 |
| Decision tree | 33 | 51 | 39 | 70 |
| Logistic regression | 36 | 58 | 42 | 70 |
| This paper | 45 | 70 | 52 | 75 |

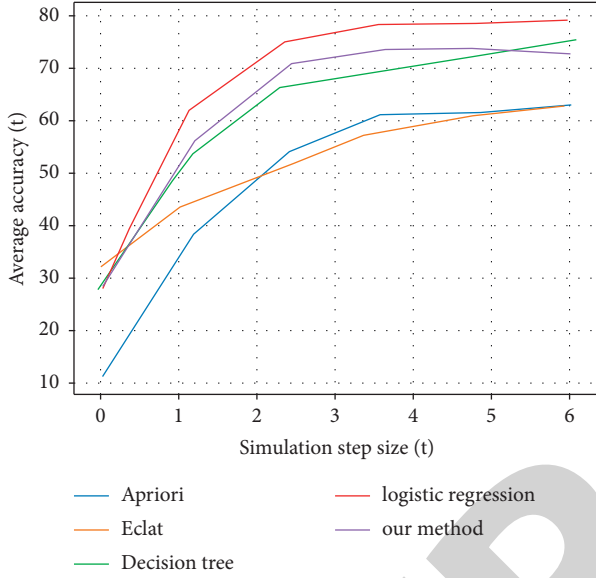


FIGURE 7: Comparison results of the average accuracy of different algorithms.

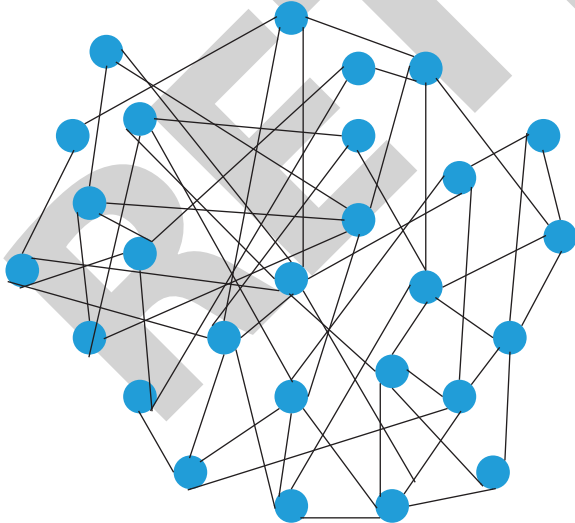


FIGURE 8: Layout of force guidance with weights.

clustering results realized based on user images are applied to the ecotourism precision recommendation process and combined with collaborative filtering algorithm to realize the recommendation of ecotourism attractions.

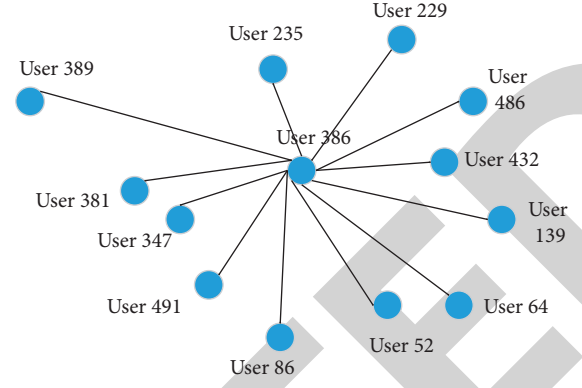


FIGURE 9: Mouse hover user 386 effect.

6. Conclusions

In order to promote the ecotourism industry in a better direction, contemporary ecotourism enterprises must grasp the follow-up work of ecotourism big data, fully excavate its value, obtain valuable information, and occupy a favorable position in the ecotourism market. In this paper, we propose a POI (point-of-interest) based system that can be used for the development of ecotourism. In this paper, we propose a personalized ecotourism route recommendation (PTIR) algorithm based on the popularity of points of interest (POI) and users' interest preferences. The results show that the accuracy and recall rate of this personalized ecotourism route recommendation algorithm are improved compared with the traditional algorithm that only considers POI popularity.

Data Availability

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

Conflicts of Interest

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

References

- [1] X. Wu, "Research on intelligent tourism management model based on big data," in *Proceedings of the Journal of Physics: Conference Series*, vol. 1992, no. 2, p. 022189, 2021 August.
- [2] H. Lv, S. Shi, and D. Gursay, "A look back and a leap forward: a review and synthesis of big data and artificial intelligence literature in hospitality and tourism," *Journal of Hospitality Marketing & Management*, vol. 31, no. 2, pp. 145–175, 2022.
- [3] L. Nahuelhual, A. Carmona, P. Lozada, A. Jaramillo, and M. Aguayo, "Mapping recreation and ecotourism as a cultural ecosystem service: an application at the local level in Southern Chile," *Applied Geography*, vol. 40, pp. 71–82, 2013.
- [4] I. Dhami, J. Deng, R. C. Burns, and C. Pierskalla, "Identifying and mapping forest-based ecotourism areas in West Virginia - incorporating visitors' preferences," *Tourism Management*, vol. 42, pp. 165–176, 2014.

Retraction

Retracted: Construction of Risk Control Decision-Making Model Platform for Transportation Hub Projects under the Background of Message Technique

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] P. Zhong, H. Yin, and Y. Li, "Construction of Risk Control Decision-Making Model Platform for Transportation Hub Projects under the Background of Message Technique," *Mobile Information Systems*, vol. 2022, Article ID 1199289, 11 pages, 2022.

Research Article

Construction of Risk Control Decision-Making Model Platform for Transportation Hub Projects under the Background of Message Technique

Ping Zhong,¹ Hang Yin ,^{2,3} and Yuanfu Li¹

¹School of Civil Engineering, Southwest Jiaotong University, Chengdu 610031, Sichuan, China

²Business School, Sichuan University, Chengdu 610031, Sichuan, China

³School of Information and Engineering, Sichuan Tourism University, Chengdu 610031, Sichuan, China

Correspondence should be addressed to Hang Yin; yinhang@my.swjtu.edu.cn

Received 22 May 2022; Revised 11 June 2022; Accepted 15 June 2022; Published 28 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Ping Zhong 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 acceleration of urbanization, the construction and operation of comprehensive transportation hub have promoted the development of regional economy. However, due to its huge scale, high building density, and crowded public space, the safety status of the comprehensive transportation hub is worrying. As the node of various transportation modes, the efficient operation of the transportation system is closely related to it, but many potential risks threaten the operation safety of integrated transportation hub all the time. Therefore, risk management is an important work to ensure the safe operation of integrated transportation hub. With the deepening of technology application, the application scope of information technology has also been expanded to complete the analysis and simulation of technical scheme and construction organization process, find problems in time, and take preventive measures, so as to optimize the design scheme, reduce unnecessary losses, and speed up the construction progress. In this study, information technology is used to construct the risk control decision model of transportation hub project. According to the research, the change of the target value of the algorithm in this study is 29% better than that of the traditional algorithm, and it can get better results and get the optimal solution quickly when applied to the intelligent traffic dispatching management system.

1. Introduction

In recent years, the completion and operation of comprehensive transportation hubs in major cities have added new impetus to China's economic arteries and promoted regional economic improvement. As an important node of the transportation network, the comprehensive transportation hub not only undertakes the transportation function but also undertakes the corresponding urban service function. Comprehensive transportation hub is not only a connecting node of urban and intercity transportation modes but also a collection of transportation, leisure, sightseeing, and other functions. The integrated advantages of comprehensive transportation hub are increasingly significant [1]. The radiation function and capacity of the core city have been greatly improved, and the connection and coupling between

metropolitan areas have been continuously enhanced. At the same time, the integrated transportation hub bears the increasing pressure of collecting and distributing passengers and faces increasing security risks. Comprehensive transportation hub is an important infrastructure to maintain urban improvement and one of the main contents of urban planning and construction administration [2]. With the rapid improvement of China's railway industry, especially the high-speed railway and intercity rail transit lines, railway passenger stations have rapidly developed into the current urban comprehensive transportation hub with their own characteristics, which is highly valued by urban planners [3]. Comprehensive transportation infrastructure has huge investment and long service life. In high-intensity areas, as the lifeline project of earthquake relief, the importance of transportation infrastructure can be imagined. If the

infrastructure suffering from severe earthquake disaster cannot be dredged in time, it will affect the efficiency of rescue and relief and even lead to secondary disasters. Comprehensive transportation hub is an important infrastructure of urban improvement and the main content of urban improvement planning and construction administration [4]. The construction and improvement of comprehensive transportation hub in megacities have gradually become a new growth pole related to urban construction and social and economic improvement. The construction, transportation, and improvement of urban comprehensive transportation hub have gradually become a new growth pole related to urban construction and social and economic improvement. With the rapid improvement of the transportation industry, the state has intensified the construction of comprehensive transportation hubs and local governments hope to rely on hub advantages to develop regional economy and actively promote the construction process of comprehensive transportation hubs [5]. When people pay too much attention to the economic benefits brought by comprehensive transportation hubs, there are also growing security risks. As a “soft target” in the domain of public security, comprehensive transportation hub security is an important part of national security and a short board that needs to be filled urgently in China’s public security system [6]. On the one hand, the improvement orientation of urban comprehensive transportation hub and the requirement of sustainable improvement of comprehensive transportation hub directly determine the changes of modern hub characteristics. On the other hand, the characteristics of the integrated transportation hub formed under the new situation also urge us to break through the original institutional constraints and reexamine the construction, transportation, and improvement mode of the integrated transportation hub from the perspective of public safety priority improvement strategy. The strategic improvement status of comprehensive transportation hub in China’s megacities has been gradually improved [7]. As an important node of traffic network construction, megacity comprehensive transportation hub plays a vital role in ensuring the strategic improvement of the urban transportation system, coordinating the smooth connection and utilization of aviation, railway, highway, and high-speed rail and subway, and ensuring the safe operation of hub. Compared with the single-function transportation hub, the multifunction comprehensive transportation hub system is more complex, and there are more transmission paths for risks. Risk changes bring greater losses to the system, and even new risks emerge due to the complex system characteristics [8]. Although there are related foundations for the research of safety risks, it is necessary to go deeper and introduce more research methods in the research and control of safety risk transmission paths combined with comprehensive transportation hubs. Comprehensive transportation hub facilities are huge in scale, high in building density, large and concentrated in passenger flow, and crowded in public space of hub, so the daily operation faces great security risks. With the further acceleration of urbanization in China, the comprehensive transportation hub, as an important node of transportation

network construction, plays a vital role in ensuring the strategic improvement of the urban transportation system, coordinating the smooth connection and utilization of railways, highways, high-speed trains, and subways, and ensuring the safe operation of hubs [9]. In areas with frequent mountain disasters, all kinds of mountain disasters will cause damage to mountain traffic, restrict road capacity, and affect operational safety. In coastal typhoon and inland strong wind areas, wind disasters have a significant impact on the structural safety of transportation infrastructure and driving safety. In our country, for a long time, we have not paid enough attention to the urban comprehensive transportation hub, and, in practice, there is a tendency of “emphasizing the line construction and neglecting the hub planning,” which makes the comprehensive transportation hub construction lag behind the diversified demand of transportation improvement for hub functions under the new situation. As an important improvement domain of urban municipal infrastructure, the rapid improvement of urban comprehensive transportation hub has brought more safety questions. In a sense, the safe improvement of hub construction and transportation is related to the success or failure of urban public safety system construction. Therefore, the construction, operation, and administration of the comprehensive transportation hub should meet the requirements of multiple functions, economy, and key engineering technologies, break through the original split administration mode, and make it gain sustainable improvement advantages under the framework of “great safety concept.”

The innovations of this study are as follows:

- (1) This study introduces the use of the message technique in the construction industry, so that readers can have a basic understanding of the research methods we want to carry out. Information society is a society in which the message industry is highly developed and occupies an advantage in the industrial structure. Informatization is a dynamic improvement process from an industrial society to a message society. It is necessary to set up a whole platform of the message technique administration system in enterprises, so that enterprises will not have questions in the future competition when software such as the administration system is biased towards hardware.
- (2) This study introduces the current situation of message administration in construction enterprises, so that we can combine the research methods with the practice. In practice, most enterprises have their own informatization improvement plans, which are well understood, valued by leaders, willing to invest resources, dare to change the traditional mode, and have strong execution. They have achieved positive results from practice or tasted the sweetness of informatization. At present, they are stepping up the implementation of enterprise collaborative administration or administration message system integration or the improvement of enterprise resource planning system.

- (3) In this study, a model is established to minimize the delay of traffic flow at the intersection, so that it can pass through the intersection smoothly. We must ensure that the signal control decision at the intersection is in realtime and accurate. The research of this model is very important, because it is the premise of establishing a scientific intelligent traffic control system to ensure that the data used for signal control decisions are forward-looking.

This article is divided into five parts.

The first part is a general introduction of this study. The second part is related academic progress and summarizes the research of this study. The third part introduces the related domains involved in this study. The fourth part is the main body of this study, which is the application of the message technique in the domain of transportation and the proposed model for testing. The fifth part is the conclusion.

2. Related Work

Karballaezadeh et al. suggested that the formation process of the transportation hub planning scheme should be taken as the logic, and the construction opportunities, strategies, and functional positioning of the hub should be systematically analyzed [10]. Lenz and Heinrichs suggested studying the emergency strategy of megacity comprehensive transportation hub, emphasizing that comprehensive transportation hub should strengthen risk prevention and emergency response in three stages, planning and design, construction, and administration and operation, and discuss from three levels: horizontal coordination, vertical logic, and emergency command [11]. Xu and Thakur suggested that the impact of large-scale hub construction on regional spatial structure should be taken as the starting point, and, considering the differences of spatial effects produced by different types of traffic facilities, the impact of their spatial structure should be discussed from four aspects: airport system, railway hub, expressway network, and inland shipping ports [12]. Zhu et al. suggested considering the whole life cycle of megacity comprehensive transportation hub, and, by comparing and analyzing the emergency administration systems at home and abroad, they proposed building a full-stage emergency administration system from planning and design to construction to operation and administration and took Hongqiao comprehensive transportation hub as an example to illustrate [13]. Lin et al. suggested expounding the motivation and research basis of emergency administration of megacity comprehensive transportation hub and analyzing its emergency administration system from the perspectives of subject, object, and environmental factors [14]. Sun suggested that the pedestrian traffic characteristics of the transfer hub should be studied, and an automatic identification congestion and emergency evacuation model should be established. Taking Xi'an North Street Station as an example, Sun et al. suggested that the service level of North Street Station should be improved, and the congestion was high. Based on brittleness theory, the best route for emergency evacuation was selected

[15]. Hung et al. suggested using the system engineering theory of "man-machine-environment-administration" to analyze various factors affecting airport flight safety, establish an analytic hierarchy process (AHP) structure model, determine the subordinate relationship between the upper and lower factors, use triangular fuzzy number complementary judgment matrix to sort, get the weight relationship between related elements, and use their different importance to sort the risk administration objects [16]. Jan et al. suggested that the mechanism of operational safety accidents and the characteristics of operational safety administration of integrated transportation hub should be studied based on vulnerability, and the integrated administration mechanism of operational safety of integrated transportation hub was constructed [17]. Xu et al. suggested that the operation and administration of integrated transportation hub can be divided into four levels: normal administration, interference administration, crisis administration, and emergency administration and systematically analyzed the administration characteristics of each level and designed the function of intelligent operation and administration system by taking the event of large passenger flow as an example, which provided a reference for later theoretical research and design and improvement of the intensive and efficient administration intelligent system [18]. Aujla et al. suggested that, in the research of trust mechanism among members of network organization, four types of factors should be extracted: organizational background of individual and node enterprises, network strategic guarantee, and trust among members. Structural equation model was used to demonstrate the direct and indirect effects of each factor, and the corresponding influence paths among the factors were obtained [19]. Slamet et al. suggested that, through the research and analysis of classic integrated transportation hub cases at home and abroad, combined with relevant theories, the proposed operation and administration mode of integrated transportation hub was studied from three aspects: operation mode, administration interface division, and operation company formation [20]. Lin et al. suggested using correlation analysis to study the correlation among four factors: carbon emission intensity, energy consumption structure, energy-capital ratio, and capital input intensity, and build a path analysis model to get the influence coefficient among all factors [21]. Jafari et al. suggested that, in the research of influencing factors and path of flight delay service recovery efficiency, four kinds of indicators, namely, responsiveness, tangibility, empathy, and reliability, should be analyzed, and the factors affecting recovery efficiency should be screened out by variance analysis, and these factors should be divided into two categories, customer quality factors and delay characteristic factors, and the six categories of indicators should be modeled by structural equation, and the path influence coefficient should be analyzed [22].

Intelligent transportation is the only way to improve the modern transportation system, and it is one of the research hotspots in the field of transportation at home and abroad. The unique mixed traffic flows in China's urban traffic interact at intersections, resulting in chaotic traffic order, increased delays, reduced traffic speed, and frequent traffic

accidents. The best way to solve traffic problems is to use intelligent traffic scientifically and reasonably. This work studies how to solve this problem and has achieved remarkable results.

3. Related Overview

3.1. Application of the Message Technique in Construction Industry. With the continuous improvement of construction enterprises, it is urgent to update the administration system. In the era of message technique explosion, it is an urgent matter for enterprises to actively integrate administration systems with emerging technologies in the face of future competition. The concept of enterprise information originated from Japan, which was put forward by Japanese scholars in 1967 with reference to industrialization. It is believed that information society is a society in which the information industry is highly developed and occupies an advantage in the industrial structure. Informatization is a dynamic development process from industrial society to information society. Since "Smart City" was put forward in 2010, China has quickly joined in the construction of "Smart City," and the concept of "Smart Site" has been derived from it in the domain of architecture. Academics and related organizations have also defined "smart worksite" one after another, but they have not yet formed a unified definition. In 1993, China's National Informatization Promotion Office first put forward the concept of informatization. However, western scholars have not put forward the idea of enterprise informatization. Their research on informatization is carried out according to specific domains such as the types of the message technique and the influence of a certain message technique or message system on organizational administration. It is necessary to set up a whole platform of the message technique administration system in enterprises, so that enterprises will not have questions in the future competition when software such as the administration system is biased towards hardware. "Smart construction site" is a concept derived from the smart city in the construction industry. It focuses on the construction site, integrates and applies advanced technologies such as Internet of Things, BIM, big data, VR, and mobile intelligent devices around production factors such as people, materials, machines, methods, and environment in the whole construction process, establishes a highly informative application system and intelligent management system, and closely integrates information technology with the construction production process to realize digitalization, information, and intelligence of the construction site. Scholars in China have also generally mentioned the concept of message enterprise; that is, message enterprise refers to an enterprise that uses the message technique in every link of production and administration, fully develops internal and external message resources and human resources, effectively improves work efficiency, administration, and decision-making level, and has core competitiveness. The hub message system is shown in Figure 1.

With the popularity of computers, more and more construction units began to hand over the original manual

work to computers. The message technique of intelligent construction site is applied to the whole process administration of construction site, which can be divided into three stages: prior planning, construction control, and later decision-making, and each stage has its core technique. The construction of the enterprise message technique platform has the most basic hardware foundation; enterprises also have certain requirements for message administration software for enterprise personnel, which make enterprises have the basic software requirements for professionals. All the software and hardware questions in the basic requirements of the message technique platform design of construction enterprises have been met. In the process of construction planning, the BIM technique has actually been involved for a long time. With the deepening of technique application, its application scope has also been expanded to complete the analysis and simulation of technical scheme and construction organization process, find questions in time, and take preventive measures, so as to optimize the design scheme, reduce unnecessary losses, and speed up the construction progress. The construction of the message technique administration platform must be refined.

As we all know, the life of a construction enterprise is the engineering quality. This makes the characteristic of delicacy necessary in enterprise administration. With the help of the message technique administration platform, enterprises must make strict requirements on the timeliness and accuracy of the platform. In fact, the process of enterprise informatization is a process in which enterprises turn from industrialization to informatization: this process includes the embodiment of productivity, which is reflected in the gradual transfer of the message technique from its application in secondary business to its application in major business. After the informatization of the enterprise, the extensive administration system in the original construction enterprise must be changed, and the business must be handled accurately and timely. The administration process must be strictly implemented and gradually developed into a precise administration system.

3.2. Present Situation of Enterprise Message Administration. To discuss the present situation of improvement and application of the message technique in construction enterprises, we must first understand the category and improvement trend of the message technique in construction enterprises. Taking the enterprise improvement strategy as the goal, taking the international advanced intensive administration as the improvement mode of enterprise administration, and taking the message technique as an important and indispensable technical means to change the traditional administration mode, improve the decision-making level of enterprise administration and enhance the improvement strength of enterprises. Among them, operator administration is to restrict and supervise the daily activities of operators and managers on the construction site. The improvement and application of the message technique in construction enterprises have developed from the initial scientific calculation (mainly structural calculation) to data

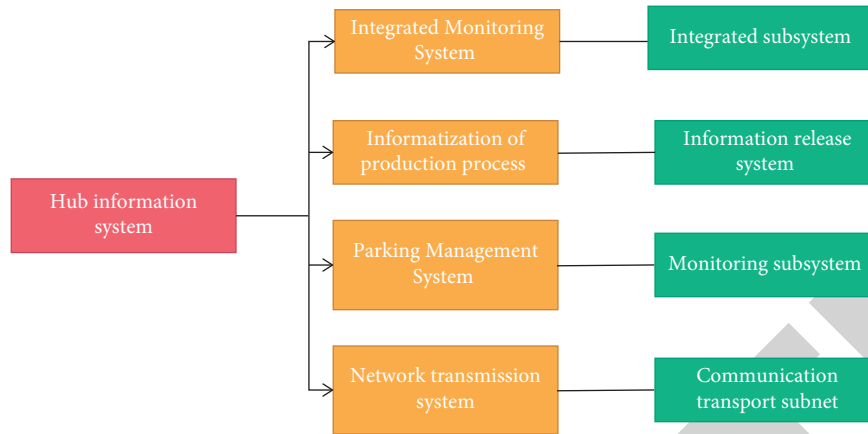


FIGURE 1: Hub message system.

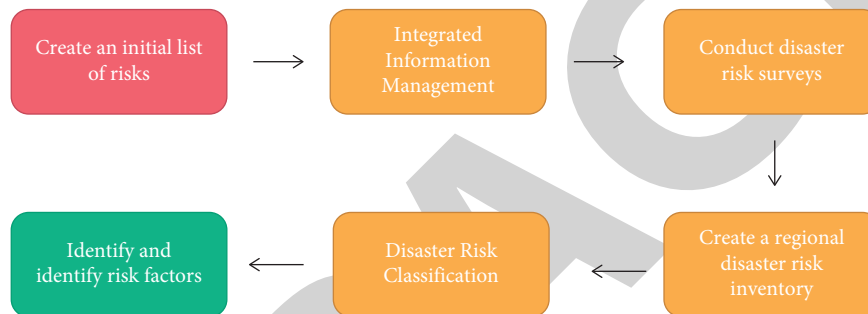


FIGURE 2: Risk analysis process.

processing (mainly financial accounting and engineering budget calculation) to the integration of the administration message system and enterprise resource planning and gradually formed two kinds of technologies: administration message technique of construction enterprises and production process message technique.

Most enterprises have their own informatization improvement plans, which are well understood, valued by leaders, are willing to invest in resources, dare to change the traditional mode, and have strong execution. They have achieved positive results from practice or tasted the sweetness of informatization. At present, they are stepping up the implementation of enterprise collaborative administration or administration message system integration or the improvement of the enterprise resource planning system. According to 4M theory, human factor is a major factor causing safety accidents. In addition, the mobility of workers in the construction area and the disorder of working paths lead to some workers operating mechanical equipment without permission or entering the operation area without permission. The traditional personnel management method makes it difficult to supervise every worker in real time, which easily leads to safety accidents. The risk analysis process is shown in Figure 2.

There are still some enterprises that do not realize the importance of the combination of informatization and enterprise improvement strategy, but they hope to keep pace with advanced science and technique and take

informatization technique as a means to solve the modernization of main business or core business in enterprises, with special emphasis on visible effects and benefits. They are not determined to change the existing administration methods of enterprises but only hope to realize their own administration methods with informatization. In order to avoid safety accidents caused by factors such as misoperation, mistaken entry, and inadequate safety awareness in such enterprises, the uniqueness of fingerprint/face recognition and the accuracy of positioning function are applied to barrier measures such as entrance guard, combined with safety education and training of VR and other advanced technologies, to reduce the number of people in the construction area and standardize the administration procedures of construction operations, so as to strengthen the standardized administration of personnel in the construction area.

Some enterprises generally have informatization plans, and their understanding and attention stay in theory, acknowledging the role and importance of informatization. However, they are very cautious in investing in informatization resources. Enterprises have basically realized the computer application of their main business and are now developing towards the integration of management information systems. The classification of the message technique in construction enterprises has not been very clear. In recent years, the research and application of the message technique in construction enterprises have been focused on

administration application. With the increasing difficulty of modern engineering design and construction, it is urgent to extend the message technique from the original scientific calculation and message administration to the design and construction process. While carrying out enterprise administration message construction, some large construction enterprises have also made active and effective explorations in applying the message technique to the construction process. There are still enterprises that only use computers as tools for enterprise staff, emphasizing the characteristics and changes of their own enterprise and project administration. They think that informatization is difficult to replace traditional administration, and there is no plan for lack of informatization plan. Apart from the indispensable budget or bidding software and financial accounting processing software, there is basically no effort in other administration message systems, especially in project administration informatization. The information technology of enterprise management in construction industry is a technology that can change the traditional business processing and management mode of construction enterprises and improve work efficiency and management level. Through the combination of information technology and management technology, the informatization technology of enterprise management can standardize and optimize the business processing and management process until the process reengineering and achieve the goal of replacing manual work with computers, quickly, preparing and orderly processing the processing and management process of construction enterprises and engineering businesses by means of information technology, assisting and supporting enterprise decision-making, pushing forward the process of business processing automation and management modernization of enterprises, and making continuous improvement. Such enterprises should adopt the message technique to keep pace with the times. Monitoring and early warning mainly refer to safety accidents caused by the factors of controlled objects. By installing wireless sensors at key positions of equipment and structures, the safety indicators of equipment and structures can be monitored all the time, thus realizing remote monitoring of safety indicators.

4. Decision-Making Model Platform for Risk Control of Transportation Hub Project under the Background of the Message Technique

4.1. Informatization of Message Traffic. With the continuous planning and construction of integrated transportation hub in China, more and more experts and scholars pay attention to the research of intelligent or message administration system of integrated transportation hub. A transportation hub is a place where passenger flow is distributed and transferred by urban external transportation modes or more than two public transportation modes or one public transportation mode with multiple lines, and it has the basic functions of transfer and multimodal transport services (the transportation hub mentioned in this article mainly refers to the passenger transportation hub). Definition of

comprehensive urban transportation hub is as follows: ① In a narrow sense, it refers to a large-scale transportation hub with both external and internal transportation functions, including a variety of transportation modes, as well as a gathering and dispersing center of people and vehicles. ② Broadly speaking, it refers to the peripheral space range centered on ① and including extension, such as peripheral roads.

Intelligent transportation message administration mode of urban comprehensive transportation hub is the specific application of administration mode in the domain of intelligent transportation message administration of urban comprehensive transportation hub. It is a set of framework systems designed according to the requirements of intelligent transportation message administration of hub, covering administration concept, administration authority, administration structure, administration content, administration tools, and so forth, and can be repeatedly applied to the intelligent transportation message administration system of comprehensive transportation hub, so as to realize efficient and safe operation and administration of hub during operation. With the rapid and sustained development of economy and the acceleration of urbanization, the single traffic mode and simple traffic function gradually change to intensive and comprehensive, forming a large or superlarge urban comprehensive traffic hub. The intelligent transportation hub system is a comprehensive information management and the control system that integrates the functions of operation management, comprehensive monitoring, disaster prevention command, traffic relief, and public security management. Combined with the administration system, administration structure, investment, and financing mode, the administration authority of urban comprehensive transportation hub includes traffic mode administration area, hub administration area other than traffic mode, and road administration area around hub.

Evaluation factor set is a comprehensive collection and summary of evaluation indicators, which can usually be divided into multiple levels:

$$F = (F_1, F_2, L, F_n) \quad (1)$$

$$F_1 = (F_{1j}, F_{12}, L, F_{1m}).$$

In the above formula, F is the evaluation factor set, F_1 is the evaluation factor, F_{1j} is the lower level subdivision evaluation factor, and so on.

A variety of possible evaluation results will be formed into a comment set, namely,

$$E = (E_1, E_2, L, E_k). \quad (2)$$

For the convenience of follow-up research, the $[0, 1]$ interval is equally divided into $(k - 1)$ sections, and each section corresponds to a comment value, namely,

$$E = (0, \Delta, L, 1), \Delta = \frac{1}{(k - 1)}. \quad (3)$$

To construct the intelligent information management system of comprehensive transportation hub, we should first

analyze its information needs. The demand comes from the service objects of the system, and the service objects of the hub intelligent information management system can be divided into government industry supervision departments, managers, travelers, vehicles, and their transportation enterprises. The intelligent transportation message administration mode of urban transportation hub is objective, comprehensive, systematic, and open. The cognition degree of hub message administration mode reflects the analysis and summary of hub operation administration rules. As a high spatial convergence of various transportation modes, integrated transportation hub needs to build many specialized message administration systems to realize comprehensive message collection, transmission, storage, and processing and provide comprehensive and efficient message services for industry administration departments, transportation enterprises, public travelers, and other users. Traffic administration areas, including terminal building, railway station building, and track station, are specially designed by professional design institutes. Hub administration areas other than traffic modes include main buildings other than traffic modes, station square, social vehicle parking lot, taxi parking lot, office buildings, municipal supporting service facilities, and shops and office buildings, which are the message design scope of urban comprehensive transportation hubs. The traffic administration department needs to fully grasp the operation status and passenger transport improvement status of the hub and analyze the rules of travel in time, space, and personnel composition according to the analysis of daily and important holiday passenger flow, traffic volume, and major emergencies, so as to provide decision support for coordinated emergency response, planning, design, and policy formulation. If the development track of cognition is correct, that is, “practice-cognition-re-practice-re-cognition,” the information management mode of hub intelligent transportation constructed in this way will have vitality and can be continuously evolved and improved. In order to effectively evaluate the operation efficiency of information management of integrated transportation hub, it is necessary to refine the evaluation indexes from macro, meso, and microperspectives.

4.2. Model Construction. Comprehensive transportation hub is a complex system, so it is necessary to analyze its risk factors in order to study its internal security risks. The improvement trend of integrated transportation hub at home and abroad shows that integrated improvement is gradually becoming the mainstream form of hub improvement in the future. Through the improvement of integrated construction, the integrity, functionality, and security of integrated transportation hub organization will be brought into full play. The historical data are tested, and the answers are shown in Figures 3–5.

Taking picture observation as the input variable of the system, the traffic flow of the intersection studied in this study is better than the traditional method. The emergence of government failure and market failure has caused people to reflect on traditional public administration, and the

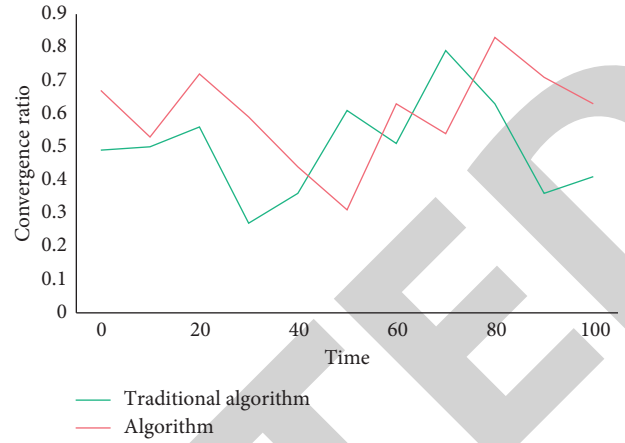


FIGURE 3: Convergence comparison diagram.

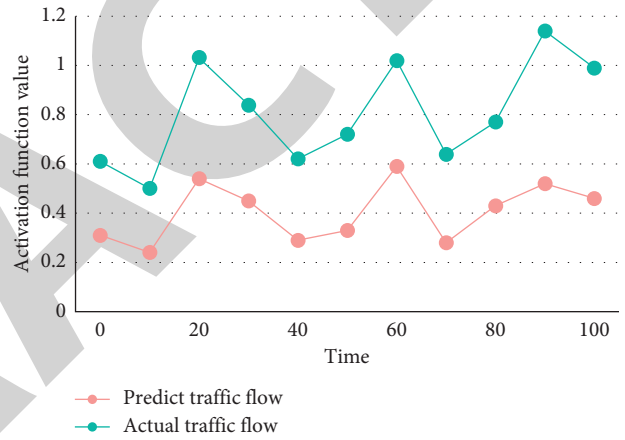


FIGURE 4: Activation function diagram of this study.

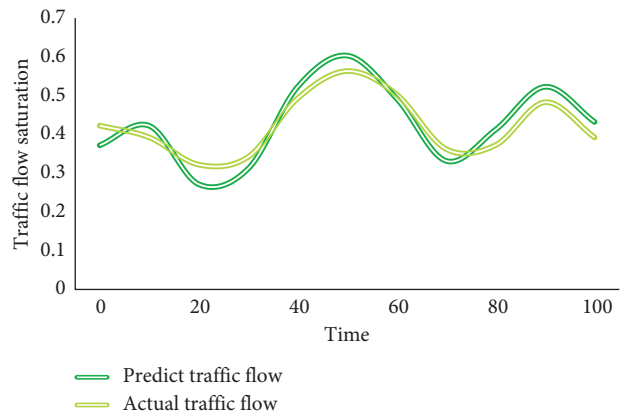


FIGURE 5: Saturation of traffic flow.

emergence of public choice theory and the practice of new public administration have laid a theoretical foundation for multisubject participation in public administration. At the same time, the improvement of civil society, scientific and technological progress, and other factors have provided necessary conditions for the implementation of governance. As a result, we began to identify risks. Risk identification is a

TABLE 1: Comparison of target average.

| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|-----------------------|------|------|------|------|------|------|------|------|------|------|------|
| Traditional algorithm | 6734 | 7031 | 6799 | 6354 | 7091 | 6466 | 5614 | 5876 | 6397 | 6506 | 6348 |
| Our algorithm | 7368 | 7164 | 6940 | 6671 | 6945 | 6833 | 7136 | 7294 | 7058 | 6732 | 7255 |

TABLE 2: Comparison of optimal individual target values.

| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|-----------------------|------|------|------|------|------|------|------|------|------|------|------|
| Traditional algorithm | 3791 | 3984 | 3288 | 3395 | 3549 | 3861 | 4081 | 3955 | 3764 | 3641 | 3887 |
| Our algorithm | 4049 | 4185 | 4397 | 5034 | 4899 | 4561 | 4294 | 4618 | 4167 | 4689 | 4824 |

very important work in the process of risk management. It is a process of detecting, judging, classifying, and analyzing potential risks. This process includes judging the disaster area, identifying the types of disasters, analyzing the disaster-causing factors, and predicting the possibility of disasters and the degree of losses caused. Comprehensive transportation hubs are generally large in scale and complex in organizational structure. The word “integration” comes from the Latin word “integratio,” which originally means “update” and “repair,” and later refers to the integration of different parts into a whole. “Integration” contains not only the concept of system integration but also the connotation of system optimization. “Integration” means that there are two or more elements or systems that can be distinguished from each other, related to each other, and interact with each other. They are distributed in a certain hierarchical structure, and, under the given environmental constraints, they form an organic aggregate to achieve the overall purpose. Next, we compare the simulation results of the target plant, as given in Tables 1 and 2 and Figures 6 and 7.

As can be seen from the figure, the change of the target value of this algorithm with the evolution algebra is 29% better than that of the traditional algorithm, and it can get better results and get the optimal solution quickly when applied to the intelligent traffic dispatching administration system. The administration and organization coordination are relatively difficult, and the uncertainty of the environment also has a great influence on it. Its operational safety also presents the characteristics of multiple disasters, and the disaster-causing factors of each disaster are different. Therefore, if we want to comprehensively, systematically, deeply, and accurately identify the risks of the comprehensive transportation hub, we must choose an appropriate risk identification method.

Here, the neural network is used to predict the short-term traffic flow. The classic neural network model is shown in Figure 8.

Let the first layer be the input layer and the second layer be the recording function layer, and both adopt Gaussian functions:

$$\mu_{ij}(x_i) = \exp\left[-\frac{(x_i - c_{ij})^2}{\sigma_{ij}^2}\right], \quad (4)$$

where μ_{ij} is the j^{th} generic function of x_i and c_{ij} and σ_{ij} are the center and width of the j^{th} Gaussian function of x_i ,

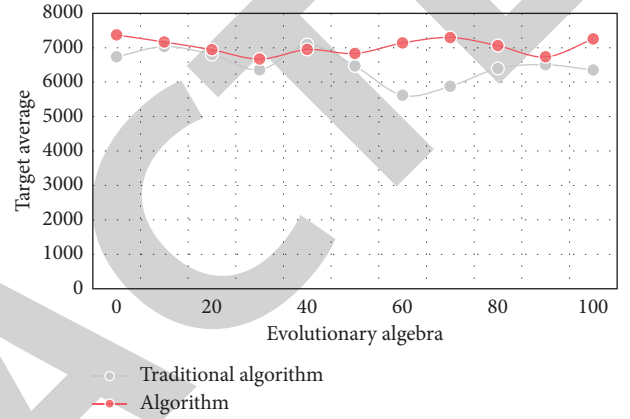


FIGURE 6: Comparison of target averages.

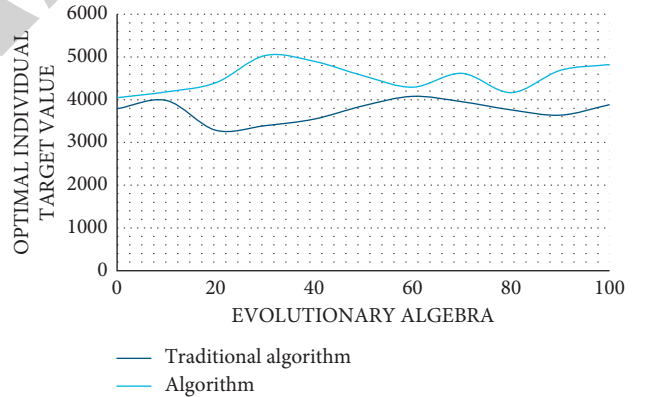


FIGURE 7: Comparison of optimal individual target values.

respectively. If the norm operator for calculating each trigger weight is multiplication, then the output of the j^{th} rule R_j ($j = 1, 2, \dots, u$) of the third layer is

$$\varphi_j(x_1, x_2, \dots, x_r) = \exp\left[-\sum_{i=1}^r \frac{(x_i - c_{ij})^2}{\sigma_{ij}^2}\right]. \quad (5)$$

Each node of the fourth layer has input signal weights and output variables:

$$y(x_1, x_2, \dots, x_r) = -\sum_{j=1}^u \omega_j \cdot \varphi_j, \quad (6)$$

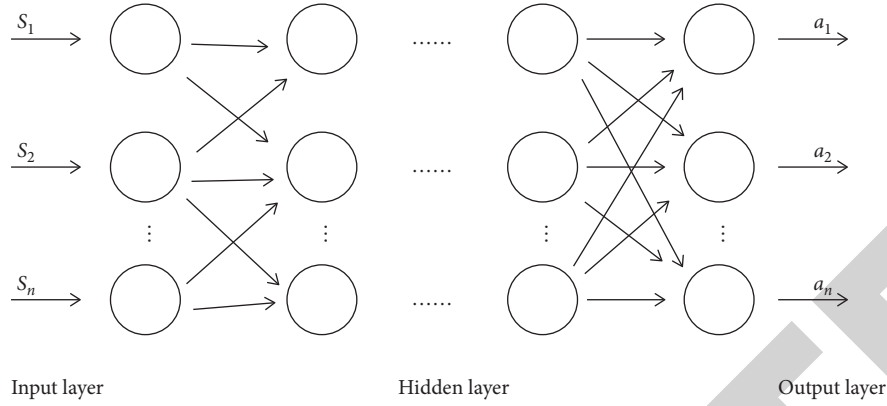


FIGURE 8: Classical neural network model.

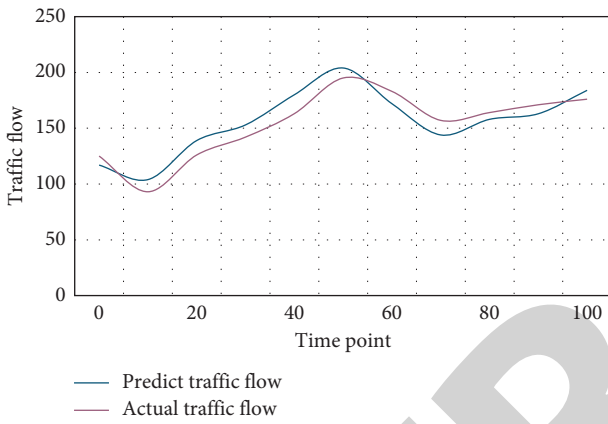


FIGURE 9: Prediction results of this algorithm.

where y is the value of an output variable and ω_j is the connection weight of the THEN part (result parameter) or the j^{th} rule.

For the TSK model,

$$\omega_j = \alpha_{0j} + \alpha_{1j}x_1 + \cdots + \alpha_{rj}x_r. \quad (7)$$

This neural network theory introduces the activation function, also known as the excitation function, which is denoted by f :

$$o = f(\text{net}), \quad (8)$$

where o is the output of the neuron. Commonly used activation functions include linear function, nonlinear function, and step function.

The general form of a linear function is

$$f(\text{net}) = k \times \text{net} + c. \quad (9)$$

In the above formula, k is the magnification factor and c is the displacement factor.

The nonlinear function is expressed as follows:

$$f(x) = \begin{cases} \gamma & \text{if } \text{net} \geq \theta, \\ k \times \text{net} & \text{if } |\text{net}| < \theta, \\ -\gamma & \text{if } \text{net} \leq -\theta. \end{cases} \quad (10)$$

The step function is as follows:

$$f(x) = \begin{cases} \beta & \text{if } \text{net} > \theta, \\ -\gamma & \text{if } \text{net} \leq \theta. \end{cases} \quad (11)$$

θ, γ, θ are all nonnegative.

The mode of “integration of construction and transportation” means that the whole process of providing products and services of urban integrated transportation hub is dominated by a main body, which, as the agent of the government, is responsible for the whole process from planning, design, and construction to operation of integrated transportation hub. Therefore, the integration mode is reflected in the integration of various functions in the form of traffic organization, and the integration research of the organization mode on the basis of function realization is more meaningful. The prediction results of this algorithm are shown in Figure 9.

It can be seen from the figure that the prediction effect of this algorithm is good, and the predicted traffic flow is consistent with the actual traffic flow trend. The composition of the integrated transportation hub itself is complex. On the one hand, because of the different functions of each system, it will bring severe challenges to the integrated operation and administration. The scale of different transportation modes is different, and the cooperation mode and efficiency among different systems are more complicated. The construction and operation of comprehensive transportation hub have changed the urban spatial structure, guided the core industrial structure, influenced the urban form and layout, and improved the regional economic competitiveness. With the rapid improvement of China's economy, comprehensive transportation has become the mainstream of transportation improvement. As the node of various transportation modes, comprehensive transportation hub plays an irreplaceable role, and the efficient operation of the transportation system is closely related to it. Therefore, it is of great significance to promote the development of comprehensive transportation hub, and the guarantee of operational safety is the most basic and important index in transportation hub. Ensuring the public safety of megacity comprehensive transportation

hub is a major challenge faced by public administration. Whether it is the response to complex social environment, the need of government function transformation, or the high responsibility for public safety, in the construction of emergency strategy of megacity comprehensive transportation hub, the participants should not be limited to the government but should be a network of benign interaction among government, market, and society.

As the gathering point of various transportation modes, the comprehensive transportation hub has the characteristics of the complex structure system, relatively closed environment, and dense crowds, which directly affects the safe operation of the whole transportation network and the construction of the urban public safety system. At present, China's comprehensive transportation hub has certain security risks. When connecting, it is necessary to consider the different risk administration methods, so that when dealing with emergencies, all systems can cooperate. On the other hand, the combination of various subsystems makes the integrated hub a more complex system, which is not only influenced by the outside world but also influenced by each other.

5. Conclusions

With the rapid improvement of China's economy, comprehensive transportation has become the mainstream of transportation improvement, and the upsurge of comprehensive transportation hub construction arises at the historic moment. As the gathering point of various transportation modes, the comprehensive transportation hub has the characteristics of the complex structure system, relatively closed environment, dense crowds, and fragile system security. Compared with a single hub, it is more vulnerable to the threat of unsafe factors. Once an accident happens, it will cause heavy casualties and huge property losses and may even lead to traffic paralysis and even affect social stability. In this study, this question is studied. After testing, the target value of this algorithm is 29% better than that of the traditional algorithm, and it can get better results and get the optimal solution quickly when applied to the intelligent traffic dispatching administration system. Comprehensive transportation hub is a complex social system, which includes people, equipment, organizations, and other participants. As a traffic node, it involves a wide range and many objects. If there is a security question, the loss will be huge, so the administration of its security risk is very important, and the means of risk administration also need innovation.

Data Availability

The data used to support this study are 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 National Natural Science Foundation of China (Integration Management of Sichuan-Tibet Railway Construction and Scientific and Technological Innovation, 71942006) and Key Projects of Sichuan 2011 Collaborative Innovation Centre: Sichuan-Tibet Tourism Industry Competitiveness Improvement Collaborative Innovation Centre, Research on the Development of Traditional Chinese Medicine Health Tourism Industry in Sichuan and Tibet (19CZZX02).

References

- [1] D. Chattaraj, B. Bera, and A. K. Das, "Block-CLAP: block-chain-assisted certificateless key agreement protocol for Internet of vehicles in smart transportation," *IEEE Transactions on Vehicular Technology*, vol. 70, no. 99, p. 1, 2021.
- [2] Y. Zhang, Y. Li, and X. Fang, "Towards spectral efficiency enhancement for IoT-aided smart transportation: a compressive OFDM transmission and regularized recovery approach," *EURASIP Journal on Applied Signal Processing*, vol. 2022, no. 1, pp. 1–16, 2022.
- [3] H. Yinglei, Q. Dexin, and Z. Shengyuan, "Smart transportation travel model based on multiple data sources fusion for defense systems," *Soft Computing*, vol. 26, no. 7, pp. 3247–3259, 2022.
- [4] C. Zhao, K. Wang, and X. Dong, "Is smart transportation associated with reduced carbon emissions? The case of China," *Energy Economics*, vol. 105, 2022.
- [5] H. Han, M. Zhou, and Y. Zhang, "Can virtual samples solve small sample size problem of KISSME in pedestrian Re-identification of smart transportation?" *IEEE Transactions on Intelligent Transportation Systems*, vol. 21, no. 9, pp. 3766–3776, 2020.
- [6] N. Sun, H. Shi, G. Han, B. Wang, and L. Shu, "Dynamic path planning algorithms with load balancing based on data prediction for smart transportation systems," *IEEE Access*, vol. 8, Article ID 15907, 2020.
- [7] A. Kumar, K. Rajalakshmi, and S. Jain, "A novel heuristic simulation-optimization method for critical infrastructure in smart transportation systems," *International Journal of Communication Systems*, vol. 33, no. 1, p. e4397, 2020.
- [8] P. P. Balbin, J. C. R. Barker, C. K. Leung, M. Tran, R. P. Wall, and A. Cuzzocrea, "Predictive analytics on open big data for supporting smart transportation services," *Procedia Computer Science*, vol. 176, pp. 3009–3018, 2020.
- [9] A. Lam, B. Azar, and G. Perun, "Smart Energy and Intelligent Transportation Systems," *Energies*, vol. 15, 2022.
- [10] N. Karballaezadeh, F. Zaremotekhas, and S. Shamshirband, "Intelligent road inspection with advanced machine learning; hybrid prediction models for smart mobility and transportation maintenance systems," *Energies*, vol. 13, 2020.
- [11] B. Lenz and D. Heinrichs, "What can we learn from smart urban mobility technologies?" *IEEE Pervasive Computing*, vol. 16, no. 2, pp. 84–86, 2017.
- [12] B. Xu and G. Thakur, "Introduction to the special issue on smart transportation," *GeoInformatica*, vol. 25, pp. 1–3, 2021.
- [13] J. Zhu, J. Huang, and H. Zeng, "Object Re-identification via joint quadruple decorrelation directional deep networks in smart transportation," *IEEE Internet of Things Journal*, vol. 7, no. 99, p. 1, 2020.

Retraction

Retracted: Construction of College Chinese Writing Practice Teaching Platform under the Background of Information Technology

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Wu, "Construction of College Chinese Writing Practice Teaching Platform under the Background of Information Technology," *Mobile Information Systems*, vol. 2022, Article ID 9038215, 9 pages, 2022.

Research Article

Construction of College Chinese Writing Practice Teaching Platform under the Background of Information Technology

Jingli Wu 

Xinxiang Vocational and Technical College, Henan 453000, Xinxiang, China

Correspondence should be addressed to Jingli Wu; 2016123465@jou.edu.cn

Received 4 May 2022; Revised 17 May 2022; Accepted 27 May 2022; Published 28 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Jingli Wu. 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.

Writing has always been one of the difficulties in teaching Chinese as a foreign language. With the advent of the information society, modern information technology, represented by networking, digitalization, multimedia, and intelligence, has become a creative tool to expand human capabilities, changing people's traditional way of life, study, and work. Guided by the theory of integration of information technology and curriculum, combined with the characteristics of Chinese writing, this paper puts forward that the goal of integration of information technology and Chinese writing is to change the traditional teaching structure, create an ideal environment for students to learn Chinese and improve their Chinese information literacy. A practical teaching platform for college Chinese writing is constructed, which is designed from the user role and based on user access control. The design includes the roles of graduate students, foreign teachers, administrators, and users. Each user has different operation rights, module rights, and management rights. According to a small amount of online information and the results of a previous course, we can make a good prediction. The results show that this method is effective, and we can predict students' academic performance through their online behavior.

1. Introduction

Writing teaching is a very important but often neglected link in all aspects of Chinese teaching, listening, speaking, reading, and writing, and it is also a generally weak link in students' abilities. Many students do not pay attention to or have no interest in writing, and they are afraid of difficulties when facing Chinese writing [1]. On the one hand, teachers are difficult to teach, although most international students can accomplish various writing tasks well in classroom teaching; on the other hand, students are hard to learn, and they feel at a loss in free writing, unable to apply the writing knowledge and methods learned in the classroom to personal writing, lacking a sense of learning gain, and losing their writing enthusiasm over time [2]. In this process, the teacher's effort and effectiveness are almost 50:1, and the result of getting twice the result with half the effort makes the students' ability not significantly improved in the writing course of more than 30 hours per semester. How to improve college students' Chinese writing levels has always been the

goal explored by most Chinese teachers [3, 4]. With the advent of the information society, modern information technology, represented by networking, digitalization, multimedia, and intelligence, has become a creative tool to expand human ability, changing people's traditional way of life, study, and work and influencing the contents and methods of education. Under the trend of integration of information technology and curriculum, how to integrate information technology with Chinese writing has become the research direction, and it will be of great significance.

At present, the teaching of Chinese as a foreign language is undergoing rapid changes and progress. Today, when the cause of teaching Chinese as a foreign language is flourishing, more emphasis is placed on the comprehensive improvement of language skills of language learners, and the classes set for improving language skills are also colorful [5]. Literature [6] points out that among the language skills of "listening, speaking, reading and writing" in teaching Chinese as a foreign language, most people think that writing is the most difficult because the writing ability reflects the

language learners' comprehensive ability to use the language. Literature [7] mentions that writing, as a basic skill of a language, has a very important position. In the process of writing, language learners need to organize language and structure, which not only consolidates the basic knowledge of Chinese but also improves the other three skills. It is not difficult to find that experts and scholars have given the writing class a high position and put forward the importance of the difficulty of the writing class is very great. Literature [8] systematically and comprehensively designed the curriculum for advanced classes, including predesign analysis, overall design arrangement, and sample class design. In the process of writing, teachers guide students to complete the writing process of preparation before writing, conception, outline writing, first draft writing, revision, discussion after revision, revision, and final draft through diversified writing activities. Therefore, rethinking the traditional writing teaching methods and means, changing teachers' one-way teaching into writing teaching with the active participation of teachers and students, strengthening comprehensive training between language skills, and improving students' writing interest and level are new topics in the reform of Chinese writing course for foreigners [9].

Essentially, the integration of information technology and Chinese writing plays a significant role in reforming the whole teaching structure, teaching methods, and learning methods. The effective integration of information technology and Chinese writing is the key to realizing the informationization of Chinese as a foreign language education and the only way to realize the informationization of Chinese as a foreign language education [10]. The learning environment of independent exploration, multi-interaction, cooperative learning, and resource sharing created by information technology has brought innovation to Chinese learners' learning style and improved their information literacy while learning Chinese. Both emphasize the interactive relationship between social culture and language. Both emphasize the function of context and the dynamic characteristics of discourse. This idea of genre theory is of great reference value to the improvement of the teaching mode of Chinese writing as a foreign language. In view of this, this paper tries to build a practical teaching platform for college Chinese writing based on previous studies and genre theory.

2. Related Work

Chinese writing teaching with multimedia and network technology as its core just reflects this teaching process, and its advantage lies in that it can effectively utilize existing resources, and students can construct their original knowledge through free exploration and free learning. Literature [11] points out that "information technology can create a student-centered, teacher-led learning environment that is connected with a wide range of communities." Literature [12] provides students with a brand-new learning and communication platform and resources and fully enables students to learn to use new means and technologies to acquire knowledge and cooperate fully in various disciplines.

Literature [13] holds that learning is not the transfer of knowledge from teachers to students but the process of students constructing their own knowledge. Students are not passive information absorbers but active constructors of meaning, which cannot be replaced by others. Literature [14] holds that teachers are organizers and guides of the teaching process and helpers and promoters of meaning construction, while students are subjects of information processing and emotional experience and active constructors of knowledge meaning. Literature [15] holds that the so-called integration of information technology and subject courses is to create a new teaching environment by effectively integrating information technology into the teaching process of various subjects and to realize a teaching and learning method characterized by "autonomy, inquiry and cooperation," which not only can play the leading role of teachers but also can fully reflect the dominant position of students. Literature [16] holds that the integration model can be divided into two categories: first, classroom instruction integration; second, autonomous learning integration; and it can be specifically divided into network teaching, individual learning, and online discussion. The integration strategies include knowledge cutting-in strategies, multiple perception strategies, practice strengthening strategies, cooperative learning strategies, and so on. Of course, the integration strategy will be more specific and targeted in terms of disciplines and even classes. Through application examples, this paper makes a comparative analysis of the teaching modes before and after multimedia enters the newspaper class [17]. The results show that multimedia plays a more important role in newspaper reading class than in other classes, which not only can help teachers complete a lot of teaching contents but also can change the boring atmosphere in the previous class.

With the rapid development of modern information technology, the application of computer and network technology in Chinese learning is becoming more and more extensive and in-depth. Especially, the connection between the Internet and campus network provides abundant resources for the education of major schools, which makes online Chinese learning based on network truly become a reality. The traditional classroom Chinese teaching can no longer meet the increasing requirements of Chinese learning, while the networked online Chinese learning system provides a large number of constantly updated resources, breaks through the geographical and time constraints, and provides students and teachers with in-class or out-of-class online learning platforms. Using the K-means algorithm, the clustering analysis results with a high degree of related attributes of course scores can be achieved well [18]. In the application of association rules, literature [19] uses association rules to analyze the key factors that affect students' performance in universities for nationalities and finds out useful rules, which can provide a reference for decision-makers to determine the future direction of teaching management. In the application of DT (decision tree), literature [20] is based on the DT model, mining the student attributes that affect the teaching effect of computer courses. Mining the data of online tools used to support collaborative learning can effectively help improve the effect of team

learning [21]. Literature [22] invented a data-driven technology to identify high-risk students at the early stage of online courses, and they found that time characteristics are the key characteristics to predicting students' academic performance. The Internet has played a decisive role in this generation of students, involving personal life and study life. According to the data of students' campus cards, literature [23, 24] measured students' campus life behavior based on entropy and defined two advanced behavior characteristics: orderliness and diligence.

3. Research Method

3.1. The Integration Model of Information Technology and Chinese Writing. Teachers can use multimedia to present teaching contents and use media information such as pictures or sounds to create a preset Chinese environment for students, in which students can train their skills. Promote students' construction, understanding, maintenance, and transfer of Chinese knowledge and skills. Students' dominant position is reflected in actively establishing the relationship between the old and new language points, acquiring the meaning of the new language points, assimilating the new language points into the original knowledge structure, and mastering the corresponding Chinese learning strategies.

Chinese writing teaching should not only pay attention to the teaching of language knowledge but also pay attention to the comprehensive training of the four skills of listening, speaking, reading, and writing, which is the core course in the Chinese writing system. In class, teachers should explain new words, grammar, and texts. Every link should be combined with practice, with more explanations and practice and mutual connection. Ask questions according to the content of the text, and the students answer the questions of the teacher. Some texts will involve several topics. Teachers should properly handle or adapt the texts to facilitate students' retelling. Teachers can create situations by using keywords, pictures, animations, and so on. Students can flexibly use sentences in the texts and retell the texts in the situations.

Teachers should not be limited to teaching materials but integrate listening materials into teaching materials. You can design the topic of real communication, such as giving a piece of material and telling it to others after listening. This communicative task-based listening training can make up for the defects of some teaching materials and also exercise students' listening and coping abilities in the process of communication. Teachers can record or collect some communication materials before class and practice with students in class. If conditions permit, teachers can make their own recorded or collected listening resources into audio task-based assignments for students and ask students to complete their own tasks, record difficult problems in the listening process, and give feedback to teachers, who can answer and help them.

The browser/server structure of the college Chinese writing practice teaching platform is the B/S structure, and the user interface is presented through the browser by the

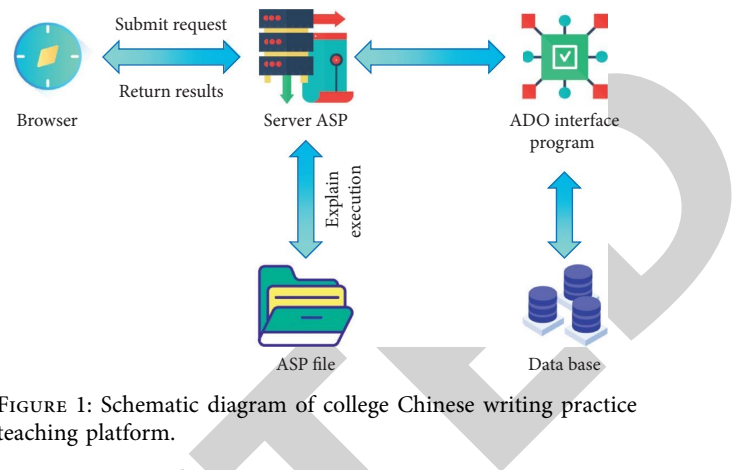


FIGURE 1: Schematic diagram of college Chinese writing practice teaching platform.

Web program. Combined with the IIS server configuration that comes with Windows, the program is written by ASP combined with database language. The system consists of three levels: client browser, Web browser, and database server. The structural principle of the system is shown in Figure 1.

From a URL request from the client to page feedback from the server to the browser, the process is as follows:

- (1) The user enters a URL address in the client browser to establish a connection with the server
- (2) The server finds the corresponding file on the hard disk according to the address requested by the user
- (3) The server side operates and interprets the file
- (4) Return the interpreted document to the client browser
- (5) End this connection

The functional module design of the college Chinese writing practice teaching platform is mainly divided into three parts: student users, foreign teacher users, and administrator users. The specific functional modules are shown in Figure 2.

The modules that students can use include the homepage of the practice platform, the latest notice, the in-service foreign teacher information module, the course reservation module, the personal course management module, the electronic magazine browsing module, and the interactive BBS module. The modules that foreign teachers can use include their own classroom student information browsing, the student evaluation module of their courses, and the homepage of the practice platform.

System administrators can add background management roles, change passwords, edit and view the homepage information, edit and view the latest notices, edit the information of available courses, and upload the description documents of each course and the information documents of foreign teachers. The teaching administrator class edits and views the feedback information of foreign teachers and students and can modify the password of foreign teachers and the scope of authority.

Teachers arrange courses on the server, compile lesson plans, and dynamically update them. The teacher can call up the learning activity tracking database of the teaching class

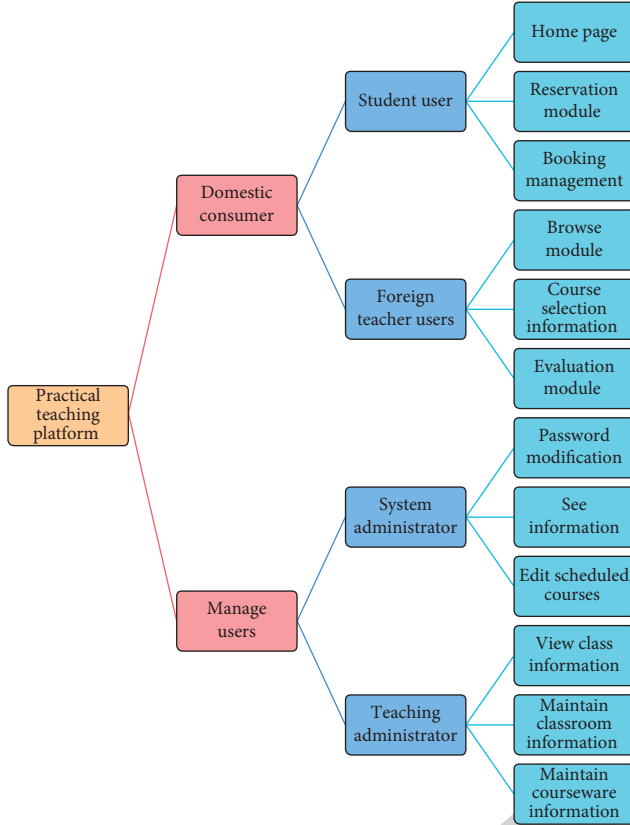


FIGURE 2: The function of the college Chinese writing practice teaching platform.

or students under his guidance and check the records and data statistics of the students' learning activities in this class. Students can browse the teaching demonstration and the courses and assignments arranged by the teacher on the client and ask the teacher questions about some problems of the online teaching demonstration and assignments through message boards or e-mails, and the teacher can answer the questions raised by the students "online."

3.2. Analysis of Students' Chinese Writing Achievements. Like other language acquisition behaviors, writing learning is social rather than isolated. Traditional writing is often an individual activity of students, and teachers are the only readers. This kind of writing can hardly help students acquire writing skills. Social interaction in the group can provide a good environment for students to write effectively and happily. This kind of social interaction has two important aspects: one is that students have a dialogue with each other, and the other is that students regard each other as editors [11]. Students' self-assessment, teachers' comments, and other forms can be used to evaluate the fluency of expression, the accuracy, and complexity of language and improve the language in various forms.

The data used in this paper comes from the open source data set of the third-party platform, which is mainly used to openly study students' personal development, supervision, and management of schools and other projects. The content

TABLE 1: Test of KM and Bartlett.

| | | |
|---|--------------------|------------|
| Kaiser–Meyer–Olkin measure of sampling adequacy | | 0.730 |
| Bartlett's test of sphericity | Approx. chi-square | 46,423.916 |
| | df | 154 |
| | Sig. | 0.000 |

of this data set includes the behavior data of students using campus smart cards to swipe their cards in two academic years of a university and the score ranking data in the teaching management system.

In order to better protect students' privacy, the scores are converted into rankings and normalized, and DM (data mining) algorithm is used for learning.

$$c_t^l = \sum_{i=1}^t \alpha_{ti} h_i, \quad (1)$$

where the context vector c_t^l can be calculated by the weighting factor α_{ti} and the hidden states h_1 to h_t ($1 \leq i \leq t$). The formula for the attention mechanism function is as follows:

$$\alpha_{ti} = \sigma(W_\alpha [h_t; h_i]), \quad (2)$$

where σ is the sigmoid function, which transforms h_t, h_i into potential space through matrix. This function does not directly add all the hidden states learned by the RNN network to represent the behavior sequence of students.

Through data transformation and integration, the data from multiple data sources are combined and then merged and converted into a form suitable for DM, so as to reduce the data, delete the attributes irrelevant to the campus card mining task in the original attribute set, and reduce the dimension.

Before factor analysis, the selected features are tested by KMO and Bartlett's test, and the KMO test is used to check the correlation and partial correlation between variables as shown in Table 1.

The results show that the approximate chi-square value of Bartlett's test is 46,423.916, and the adjoint probability value is $\text{Sig.} < 0.05$, which is significant. It shows that the correlation coefficient matrix of the factor is not an identity matrix, and there is a correlation among the variables.

3.3. Achievement Prediction Based on DM. DM is the process of extracting hidden information and knowledge from a large number of incomplete, noisy, fuzzy, and random data that people do not know in advance, but it is potentially useful. Because most clustering analysis algorithms cluster according to the distance between data objects, this algorithm is only suitable for the clustering of spherical classes but cannot be used to analyze the clustering of other shape classes, so a density-based clustering method is proposed. The basic idea is that in a given range, if the density of data points is not less than the set minimum threshold, it will be divided into similar classes.

In many applications, the relationship between attribute sets and class variables is uncertain. That is to say, although

the properties of the test record are the same as some training samples, it is impossible to predict its class label with certainty. In this study, two common classification algorithms, naive Bayes and LR, are mainly used.

NBC (naive Bayesian classification) is a simple probabilistic classification based on Bayesian theory. It assumes that features are independent of each other; that is, it assumes that every feature of a sample is uncorrelated with each other [17]. This classification method relies on an accurate natural probability model, is famous for its acceptable accuracy and high efficiency, and can achieve very good classification results in the supervised learning sample set.

Given the class label C_i of tuple X , make the naive assumption that the attribute values are independent of each other, that is, assume that A_1, A_2, \dots, A_n attributes are independent of each other conditionally. In this way, the posterior probability of X under the condition of C_i can be converted into

$$P(X|C_i) = \prod_{k=1}^n P(x_k|C_i) \quad (3)$$

$$= P(x_1|C_i) \times P(x_2|C_i) \times \dots \times P(x_n|C_i).$$

We can easily estimate the probability $P(x_1|C_i), P(x_2|C_i), \dots, (x_n|C_i)$ from the training tuple, where x_k represents the value of attribute A_k of tuple X .

In order to predict the class label of the class to which tuple X belongs, $P(X|C_i)P(C_i)$ is calculated for each class C_i . The class label of NBC tuple X is C_i , if and only if

$$P(X|C_i)P(C_i) > P(X|C_j)P(C_j) \quad 1 \leq j \leq m \quad (4)$$

$$P(X|C_i)P(C_i) > P(X|C_j)P(C_j) \quad 1 \leq j \leq m.$$

That is, the predicted class mark is the class C_i that maximizes the $P(X|C_i)P(C_i)$ value.

NBC has the advantage that it performs well on small-scale data and is suitable for multi-classification tasks and incremental training. The disadvantage is that it is sensitive to the expression form of input data. If the given feature vectors are of different lengths, they need to be normalized to vectors of the same length.

LR (logistic regression) is a generalized nonlinear regression analysis model for classification, which is often used in DM, automatic disease diagnosis, economic prediction, and other fields. Through LR analysis, the weight of the independent variable can be obtained so that you can roughly know which factors are the main factors of the dependent variable. At the same time, according to this weight, the possibility that an instance belongs to a certain category can be calculated with independent variables.

The assumption h_θ of the LR model is

$$h_\theta(x) = g(\theta^T X), \quad (5)$$

where X represents eigenvector, g represents a logic function, and a commonly used logic function is S-shaped function, and the formula is:

$$g(z) = \frac{1}{1 + e^{-z}}. \quad (6)$$

In order to make the algorithm predict and classify well, it is necessary to find the appropriate parameter vector θ of the model. The selected parameters determine the accuracy of the obtained $h_\theta(x)$ relative to the training set, and the difference between the class predicted by the model and the class in the training set is called modeling error. The purpose of determining the parameter θ is to select the model parameters that can minimize the absolute value of the modeling error.

LR's cost function is

$$J(\theta) = \frac{1}{m} \sum_{i=1}^m \cos t(h_\theta(x^{(i)}), y^{(i)}), \quad (7)$$

where

$$\cos t(h_\theta(x), y) = \begin{cases} -\log(h_\theta(x)), & y = 1, \\ -\log(1 - h_\theta(x)), & y = 0. \end{cases} \quad (8)$$

The $\cos t(h_\theta(x), y)$ feature is characterized by the following:

When the actual $y = 1, h_\theta(x) = 1$, the error is 0, and when $y = 1, h_\theta(x) \neq 1$, the error increases with the decrease of $h_\theta(x)$.

The error is 0 when $y = 0, h_\theta(x) = 0$ is actual, and it becomes larger when $h_\theta(x)$ is larger when $y = 0, h_\theta(x) \neq 0$ is actual.

4. Results and Discussion

While students often improve their fluency, the accuracy of language expression is still low. Writing is essentially an act of self-control. If there is no specific requirement, foreign language learners are likely to use only their familiar language forms to express their thoughts and at most improve their proficiency in foreign language use. When writing, you can choose some words related to the writing theme and ask students to choose at least a certain number in writing. Only deliberately noticed language points are more likely to be remembered and used, and intentional attention is very important for foreign language development.

The principal component analysis is used to investigate the correlation between multiple variables and the prediction function, and seven factors affecting students' grades are analyzed, as shown in Figures 3 and 4.

Campus card swiping is a spontaneous behavior of students, and it is also an important factor to reflect students' academic performance. Due to the individual differences of each student and the diversity and complexity of environmental factors, the model cannot be generalized and explained only by extracting the characteristics of campus credit card swiping behavior. Behavioral indicators that affect academic rankings can be discussed in conjunction with the categorization of student achievement, and the DM algorithm is used to explore the practical value of these behavioral data in management, teaching, and learning.

Based on the traditional behavior characteristics, the experiment builds Bayesian, DT, LR, RF (random forest),

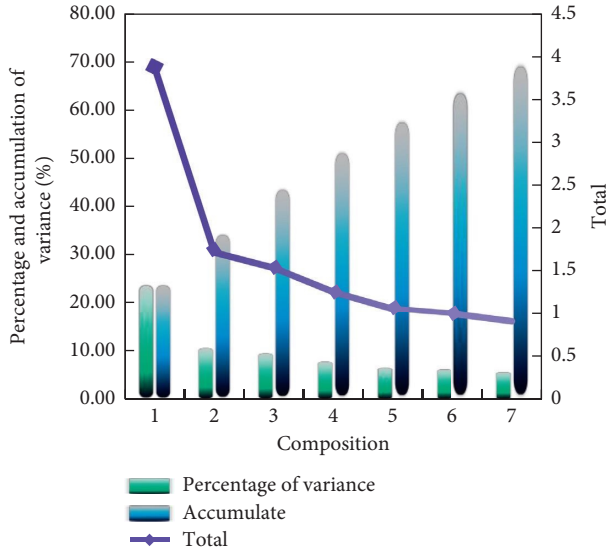


FIGURE 3: Initial eigenvalue.

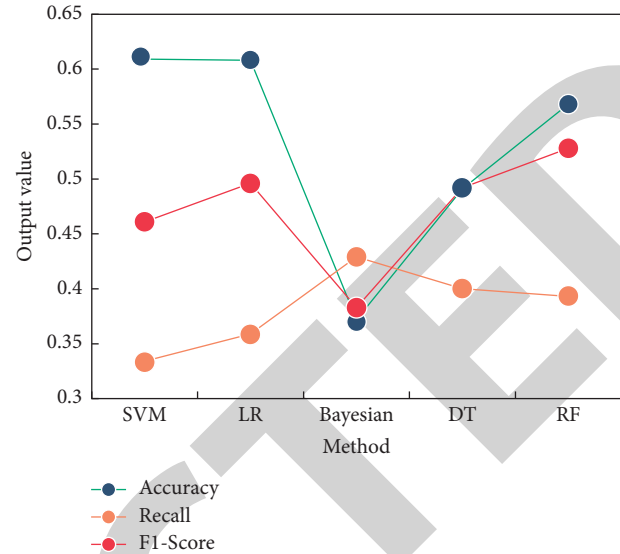


FIGURE 5: Classification experiment results.

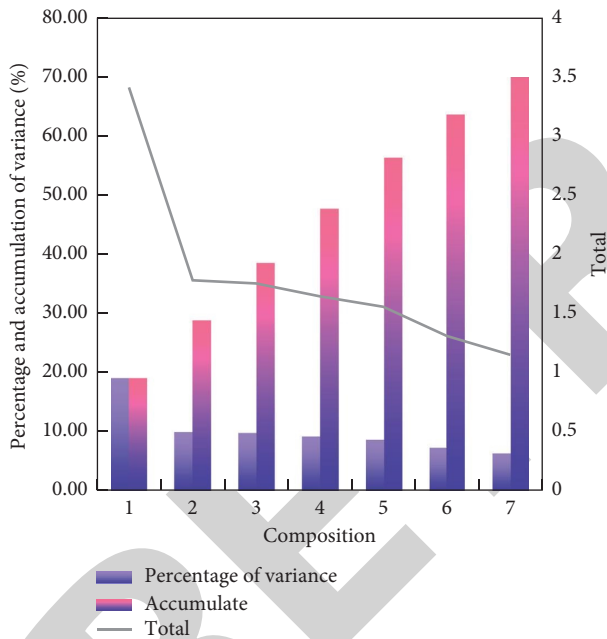


FIGURE 4: Rotating sum of squares loading.

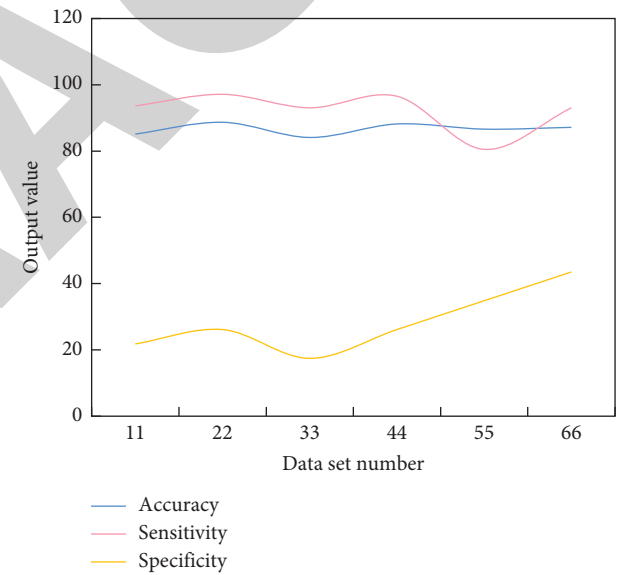


FIGURE 6: Prediction results on data sets.

and SVM (support vector machine) multi-classification prediction models and uses three evaluation methods, namely accuracy, recall, and F1-score, to evaluate the performance prediction models. The experimental results are shown in Figure 5.

The optimization of the algorithm can only improve the final experimental results to a certain extent, and the core that really determines the quality of the model lies in the original data. People's empirical understanding of campus behavior needs to be biased. Therefore, combining the principles of psychology, statistics, and pedagogy, further empirical analysis or more experimental data are needed to extract the effective features.

Generally speaking, the research in this chapter is feasible to predict students' performance ranking by using students' behavior data. Compared with other classification algorithms, SVM and LR have stronger learning abilities for the extracted traditional behavior characteristics, and the accuracy of the trained classification prediction model is relatively higher. Based on the above analysis, it reflects the importance of data analysis and feature extraction and points out the direction to further improve the accuracy of performance prediction.

Figure 6 lists the sensitivity, specificity, and accuracy obtained by using the LR algorithm to predict whether Chinese writing will pass or not on six different data sets and using the leave-out-of-one cross-validation method to evaluate the model.

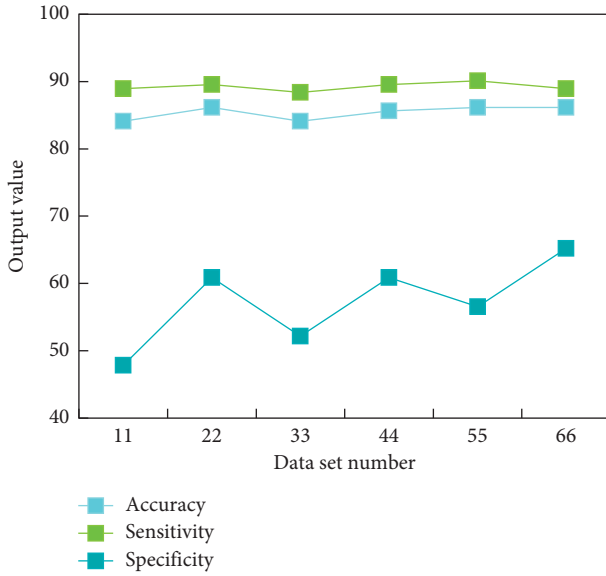


FIGURE 7: Using NBC's prediction results on six kinds of data sets.

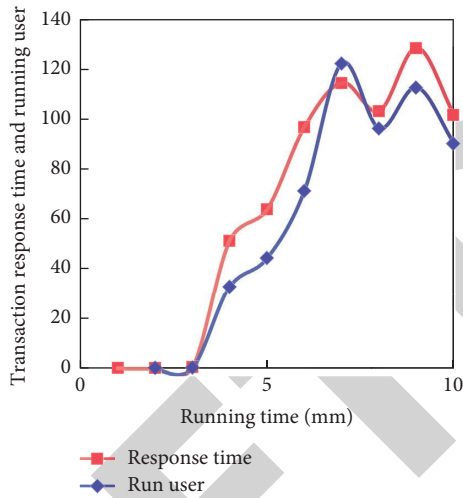


FIGURE 8: Test results of 4 M network.

As shown in Figure 6, the accuracy rate is about 85% for all data sets, with little fluctuation. Except for data set 55, which is relatively low in sensitivity, the other five groups of data all exceed 90%. For six groups of data sets, the difference in specificity is the most obvious.

Figure 7 lists the sensitivity, specificity, and accuracy obtained by using naive Bayes classifier to predict whether students' Chinese writing course will pass the experiment on six different data sets and by using the leave-out-of-one cross-validation model.

As shown in Figure 7, the accuracy and sensitivity are stable at around 85% and 90% in all data sets, respectively, but the difference of specificity is obvious. Here are two interesting results about the specificity: the specificity increases by at least 4% when an extra item is added to the data set, and when the features were transformed to be closer to a Gaussian distribution, the specificity increases by about 10%.

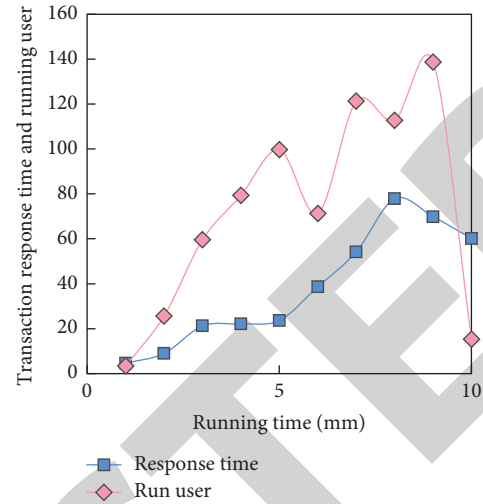


FIGURE 9: Test results of 10 M network.

The performance test is to judge whether the system function meets the performance indicators it should achieve, such as concurrency, load, and so on, when the system function is already available. The performance test of the college Chinese writing practice teaching platform adopts the automatic test tool Load Runner v9.0, and the virtual users are generated by the load operation controller of the automatic test tool to test the load pressure.

This section takes the download of teaching resources as an example and tests the number of concurrent users to meet the system requirements and what improvements should be made in the server hardware configuration under the conditions of 4 M and 10 M bandwidth networks, respectively.

Figure 8 shows the test results of downloading teaching resources under 4M broadband. From this figure, it can be seen that the transaction response time increases in direct proportion to the number of virtual users. When the number of users reaches 155, the transaction execution fails, prompting the download timeout.

Looking at the CPU utilization rate at this time, as shown in Figure 8, it can be found that it does not consistently reach 100%; when the transaction is completed, its utilization rate dropped to a relatively low level. Therefore, a conclusion can be drawn. In order to achieve the expected concurrency of 200 users, the bandwidth at this time will become the bottleneck of downloading resources.

Figure 9 shows the test results of downloading teaching resources under 10 M broadband. From this figure, it can be seen that the transaction response time increases in direct proportion to the number of virtual users. When the number of users reaches 220, the transaction execution fails, prompting the download timeout.

Observing the CPU utilization rate at this time, as shown in Figure 9, it can be found that the CPU utilization at this time has reached 100%, so a conclusion can be drawn. In order to achieve the expected concurrency of 200 users, the server hardware configuration at this time becomes the bottleneck of downloading resources.

Through the above tests, it can be concluded that the function of downloading resources in the online classroom needs to provide 10 M network bandwidth to ensure that 200 students can download teaching resources at the same time, and at the same time, the existing server configuration should be upgraded in hardware. System testing is an important work to ensure the quality of software. In the life cycle of software development, testing plays a very important role.

5. Conclusion

This topic is based on solving the limitations of a class setting, lagging content of teaching materials, role change of teaching and learning in teaching methods, cultivation of students' autonomous learning ability, individualization, informationization, and innovation of network teaching of Chinese writing class, and so on. Put forward the practical teaching platform of college Chinese writing, realize the digital learning of Chinese, and the goal of integrating information technology with Chinese as a foreign language is to change the traditional teaching structure, create an ideal environment for students to learn Chinese, and improve their Chinese information literacy. In the system of teaching management, users can operate on any networked computer, and the statistical function of the management system can check the situation of students' booking for class in real time. Through the statistical analysis, the correlation between traditional features and grades ranking is explored. Finally, the features with high correlation are selected as the main behavioral features of students, and a classification prediction experiment is carried out by using the DM algorithm to design a grades prediction model. It is concluded that naive Bayes classification algorithm is more applicable in this study, and its performance can be applied to practical systems.

Data Availability

The figures and tables used to support the findings of this study are included within the article.

Conflicts of Interest

The author declares that there are no conflicts of interest.

References

- [1] K. Y. Chen, "Time and landscape at the beginning of Chinese writing," *Journal of Chinese Linguistics*, vol. 48, no. 2, pp. 323–341, 2020.
- [2] S. C. Tsai, "Implementing interactive courseware into EFL business writing: computational assessment and learning satisfaction," *Interactive Learning Environments*, vol. 27, no. 1–4, pp. 46–61, 2019.
- [3] J. Liao, "Do L2 lexical and syntactic accuracy develop in parallel? Accuracy development in L2 Chinese writing," *System*, vol. 94, Article ID 102325, 2020.
- [4] Y. Yang, Z. Zuo, F. Tam et al., "Brain activation and functional connectivity during Chinese writing: an fMRI study," *Journal of Neurolinguistics*, vol. 51, pp. 199–211, 2019.
- [5] J. Liao, "The impact of face-to-face oral discussion and online text-chat on L2 Chinese writing," *Journal of Second Language Writing*, vol. 41, pp. 27–40, 2018.
- [6] Y. Li, H. Li, and M. Wang, "Orthographic learning via self-teaching in Chinese: the roles of phonological recoding, context, and phonetic and semantic radicals," *Journal of Experimental Child Psychology*, vol. 199, Article ID 104913, 2020.
- [7] Y. Zheng, S. Yu, and I. Lee, "Implementing collaborative writing in Chinese EFL classrooms: voices from tertiary teachers," *Frontiers in Psychology*, vol. 12, Article ID 631561, 2021.
- [8] Y. Mori, A. Hasegawa, and J. Mori, "The trends and developments of L2 Japanese research in the 2010s," *Language Teaching*, vol. 54, no. 1, pp. 1–38, 2020.
- [9] Y. Ye, M. Yan, Y. Ruan, C. McBride, and C. F. Yeung, "Literacy learning in early Chinese-English bilinguals: the role of pure copying skill," *Early Childhood Research Quarterly*, vol. 55, pp. 263–274, 2021.
- [10] W. Xu and J. Knijnik, "Critical Chinese as an Additional Language education in Australia: a journey to voices, courage and hope," *British Educational Research Journal*, vol. 00, pp. 1–15, 2021.
- [11] Y. Zhang, H. Peng, and Y. Bian, "Interplay between reading and writing under different teaching models: a study based on Chinese learning by China's ethnic minorities," *Frontiers in Psychology*, vol. 11, p. 2150, 2020.
- [12] L. Li, H.-C. Wang, A. Castles, M.-L. Hsieh, and E. Marinus, "Phonetic radicals, not phonological coding systems, support orthographic learning via self-teaching in Chinese," *Cognition*, vol. 176, pp. 184–194, 2018.
- [13] Y. Zhang, "Adversative versus concessive while-clauses in native and learner English texts: a corpus-based systemic functional description," *Digital Scholarship in the Humanities*, vol. 35, no. 3, p. 3, 2019.
- [14] Z. Han, "Task-based learning in task-based teaching: training teachers of Chinese as a foreign language," *Annual Review of Applied Linguistics*, vol. 38, pp. 162–186, 2018.
- [15] J. Liu, G. Shi, J. Zhou, and Q. Yao, "Prediction of college students' psychological crisis based on data mining," *Mobile Information Systems*, vol. 2021, no. 23, Article ID 9979770, 7 pages, 2021.
- [16] M. Bhat, M. Zaman, and M. Butt, "An intelligent prediction system for educational data mining based on ensemble and filtering approaches," *Procedia Computer Science*, vol. 167, no. 2, pp. 1471–1483, 2020.
- [17] F. Yang and F. W. B. Li, "Study on student performance estimation, student progress analysis, and student potential prediction based on data mining," *Computers & Education*, vol. 123, pp. 97–108, 2018.
- [18] C. Wang, J. Bi, Q. Sai, and Z. Yuan, "Analysis and prediction of carsharing demand based on data mining methods," *Algorithms*, vol. 14, no. 6, p. 179, 2021.
- [19] T. R. Kumar, P. Yasaswini, G. Rafi, and D. V. Krishna, "Comparative analysis on job prediction of students based on resume using data mining techniques," *International Journal of Engineering & Technology*, vol. 7, no. 2.7, p. 1100, 2018.
- [20] Z. Xu, H. Yuan, and Q. Liu, "Student performance prediction based on blended learning," *IEEE Transactions on Education*, vol. 64, no. 99, pp. 1–8, 2020.
- [21] L. Huang, "Design of an IoT DDoS attack prediction system based on data mining technology," *The Journal of Supercomputing*, vol. 78, no. 8, pp. 1–23, 2021.

Retraction

Retracted: Bayesian Network Structure Learning and Application

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Zhang, D. Liu, Z. Wang, and X. Wang, "Bayesian Network Structure Learning and Application," *Mobile Information Systems*, vol. 2022, Article ID 7642339, 9 pages, 2022.

Research Article

Bayesian Network Structure Learning and Application

Liwei Zhang^{1,2,3}, Dayou Liu,^{1,2} Zheng Wang,^{1,2,4} and Xinlu Wang¹

¹College of Computer Science and Technology, Jilin University, Jilin 130012, China

²Key Laboratory of Symbolic Computation and Knowledge Engineering of Ministry of Education, Jilin University, Jilin 130012, China

³Department of Computer, Aviation University of Air Force, Jilin 130022, China

⁴Engineering Training Center, Changchun Institute of Engineering, Jilin 130012, China

Correspondence should be addressed to Liwei Zhang; 2016124153@jlu.edu.cn

Received 4 May 2022; Revised 25 May 2022; Accepted 31 May 2022; Published 28 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Liwei 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.

With the continuous development of artificial intelligence technology and information technology, a large number of background data are constantly generated. How to obtain effective and useful data in a large and complex data group becomes important and meaningful. The traditional Bayesian network can represent the probability distribution of data variables from a large number of data based on graphical models. It has relatively clear and reliable reasoning ability and decision-making mechanism. However, the traditional Bayesian network structure has serious shortcomings in the recognition accuracy of corresponding key data, so the efficiency of the corresponding algorithm is seriously low. Based on this, this study adds an adaptive genetic algorithm with causality to the original Bayesian structure, so as to optimize the strategy of its structure operation, quantitatively describe the order of the corresponding data nodes, creatively arrange the corresponding data nodes in order by using the node priority, and initialize the initial architecture of Bayesian network based on this. Finally, the network is initialized through information exchange and data score correction, so as to get the final learning results. In this study, the convolution neural network algorithm in a database is verified in the experiment. The experimental results show that the accuracy of the experimental results given by the Bayesian network structure proposed in this study is about 10% higher than the traditional accuracy, and its corresponding learning results basically cover the important algorithms, hypotheses, and verification of convolution neural network, from this level; the algorithm proposed in this study has obvious advantages in bibliometrics.

1. Introduction

With the continuous development of information technology and artificial intelligence technology, all kinds of corresponding data show geometric explosive growth. How to classify, process, find, and identify useful data in the database becomes very important and meaningful. Conventional data mining or data recognition technologies include various classical data mining and classification algorithms such as probability and statistics methods and fuzzy logic methods [1–3]. As a probability network that can graphically represent the relationship between random variables, Bayesian network data structure is essentially a causal learning network. It is essentially a directed acyclic graph. The corresponding data nodes represent the corresponding random variables, and the directed edges between

the corresponding nodes represent the causal relationship between data; at the same time, the conditional probability strength between the corresponding data represents the relationship strength between the corresponding data nodes. The Bayesian structure combines the information of some corresponding nodes with the corresponding probability reasoning to realize the probability information of other data nodes. The recognition model with Bayesian network characteristics derived from this Bayesian model is as follows: Kalman filter, dynamic Bayesian model, and dynamic Bayesian network [4, 5].

The conventional Bayesian model has obvious advantages in data processing and identification, its corresponding Bayesian network has the characteristics of intuitive and easy to understand, its corresponding data network has strong comprehensibility and interpretability, and the dependency

between corresponding data is also very clear; conventional Bayesian network has good preciseness, its corresponding network model is based on a mathematical model, and its corresponding network reasoning process is very rigorous [6, 7]; the corresponding Bayesian network has better flexibility in processing and identifying the corresponding data information. Its corresponding Bayesian network can combine the corresponding prior knowledge and can also carry out data learning and analysis from a large number of databases. The corresponding theoretical basis is the continuous reasoning of probability theory knowledge [8]; the conventional Bayesian network has strong interpretation accuracy, which can accurately and quantitatively describe the dependencies corresponding to the corresponding data variables [9, 10]. When the conventional Bayesian network data structure expresses the uncertainty problem, it can analyze the corresponding data problem from both qualitative and quantitative levels; the conventional Bayesian network structure is essentially an important data mining tool. It can classify, cluster, and predict a large number of data. Its corresponding expressiveness, comprehensibility, interpretability, and strict logic make the Bayesian structure closer to the corresponding practical problems [11]. However, the traditional Bayesian network structure has serious shortcomings in the recognition accuracy of the corresponding key data, so the efficiency of the corresponding algorithm is seriously low.

Based on the analysis of the current situation of Bayesian network structure, this study will add an adaptive genetic algorithm with causality to the original Bayesian structure, so as to optimize its structure operation strategy, quantitatively describe the order of corresponding data nodes, innovatively arrange the corresponding data nodes in order using node priority, initialize the initial architecture of Bayesian network based on this, and finally modify the initialization network through information reciprocity and data scoring, so as to obtain the final learning results. In this study, the convolution neural network algorithm in a database is verified in the experiment. The experimental results show that the accuracy of the experimental results given by the Bayesian network structure proposed in this study is about 10% higher than the traditional accuracy, and its corresponding learning results basically cover the important algorithms, hypotheses, and verification of convolution neural network, from this level; the algorithm proposed in this study has obvious advantages in bibliometrics.

The structure of this study is arranged as follows: the second section of this study will analyze and study the current research status of Bayesian network structure; the third section analyzes the principle of causal adaptive genetic algorithm in the improved Bayesian network structure; the fourth section of this study will experiment with the algorithm proposed in this study and analyze the experimental results; finally, this study will be summarized.

2. Research Status of Sports Video Athlete Detection Technology

Based on the application of Bayesian network in the uncertainty of network data, a large number of scholars and research institutions have carried out research and analysis

on it. The corresponding research results mainly focus on Bayesian network theory learning, the combination of expert domain learning and Bayesian network theory learning, and the research on the practical application of Bayesian network. The relevant scientists in the United States have carried out systematic research and analysis on the theory of Bayesian network, and their corresponding segmentation principles play an important role in the follow-up classical Bayesian learning [12, 13]; at the level of Bayesian network structure model research, the main theories focus on the corresponding modeling processing based on domain expert knowledge and determine the probability learning distribution of each variable according to parameter learning method. However, this construction method greatly shows the disadvantages of the Bayes network framework [14]; the relevant European research institutions and corresponding scientists have proposed the Bayesian construction algorithm based on dependency analysis. It mainly detects variables based on the interrelationship between variables, thus determining the corresponding direction and other parameters among different variables. Finally, based on this, the corresponding Bayesian network architecture diagram is constructed. The corresponding algorithms integrate statistical theory, information theory, and other relevant algorithms, but the Bayesian network construction efficiency of the algorithm is low [15]; based on the above network, the corresponding researchers propose a conditional independence detection algorithm to improve the construction strategy of Bayesian network, but the construction method requires a high sample capacity of training [16, 17]; the corresponding researchers proposed a hybrid construction method based on the disadvantages of Bayesian network constructed on independent conditions. It mainly used an independence test to get a fuzzy Bayesian network and then the heuristic search algorithm based on the scoring function algorithm, which solved the drawbacks existing in the previous two algorithms when they were running separately [18–20]. Based on the above analysis and research, the Bayesian network structure has obvious advantages in the information uncertainty expression and probability distribution, but it still has more or less recognition accuracy and multinode and complex node identification problem.

3. Bayesian Network Analysis Based on Improved Genetic Algorithm

The main idea of this study is to add an adaptive genetic algorithm with a causal relationship into the original Bayesian structure, so as to optimize the strategy of its structure operation, quantitatively describe the corresponding data nodes in order, arrange the corresponding data nodes in order by node priority, and initialize the Bayesian network initial architecture based on this. Finally, the network is initialized through information exchange and data score correction, so as to get the final learning results. The corresponding Bayesian network construction framework is shown in Figure 1. From the figure, we can see the corresponding core modules in the algorithm proposed in this study.

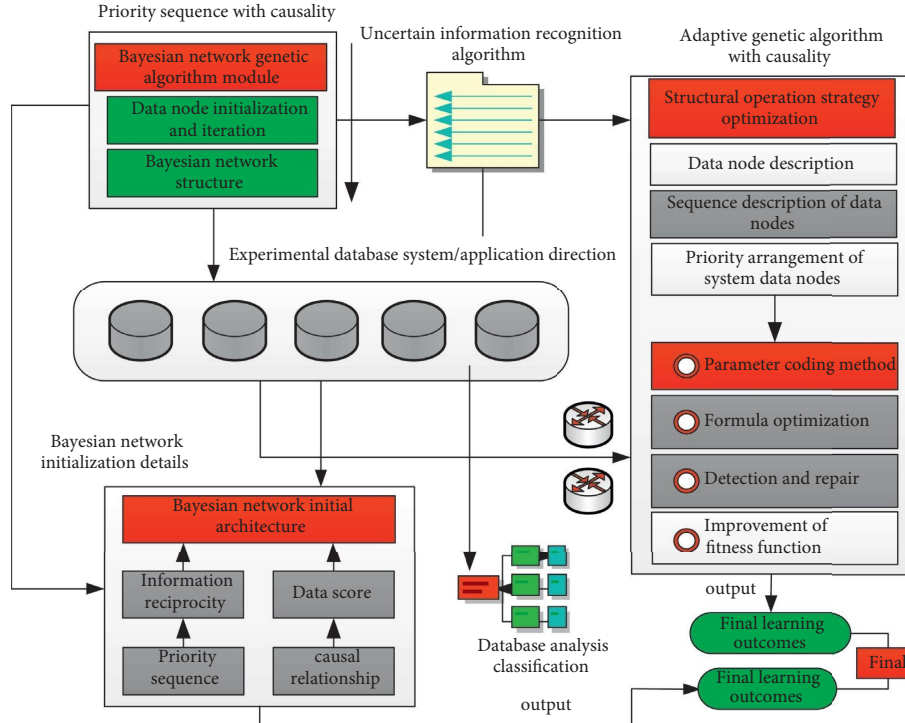


FIGURE 1: Schematic diagram of Bayesian network architecture.

In view of the increase of causality factors in this algorithm, we first need to solve the priority problem between data nodes. As long as the corresponding priority sequence follows the corresponding sequence A, sequence B, and sequence C, the corresponding three sequences determine the priority sequence of the data nodes in turn. The node priority of corresponding different data shows the priority of the data node compared with other data in the network. The corresponding data priority network structure schematic diagram is shown in Figure 2. It can be seen from Figure 2 that the priority relationship between corresponding data is mainly the hierarchical relationship between data nodes. In the actual priority arrangement, it is necessary to calculate the sum of mutual information between nodes with the same priority among different data and other data nodes of the system.

Based on the solution of the above priority problem, the genetic algorithm in its Bayesian network is improved. The corresponding improved processing level mainly includes four levels, and the corresponding optimization framework is shown in Figure 3. At the level of data parameter coding, the traditional data parameter coding method is abandoned, the Bayesian network structure is represented by the matrix corresponding to $m * m$, and the corresponding adjacency matrix in the Bayesian network structure is represented by matrix h . In the actual genetic operation and corresponding coding optimization process, the adjacency matrix in the Bayesian network is directly regarded as an individual in the system. The corresponding operation of the adjacency matrix is regarded as the operation of the system individual. Finally, the Bayesian network architecture is constructed based on the adjacency matrix; in the corresponding Bayesian network initialization population, the node mutual

information formula based on information theory is optimized and improved. For the data edge in the independent mapping, the corresponding node is retained and removed by determining the corresponding obstacle set. Based on this operation step, the corresponding candidate Bayesian network structure can be further obtained; based on the fitness function of detection and repair the abnormal network structure is detected, repaired, and removed in the process of population or data iteration and the fitness of the remaining structure or population is detected. The detection tool used is the fitness function. Based on this, the better the individual, the higher the corresponding fitness. In this study, the selection of fitness function is mainly based on the scoring function; the control parameter optimization of genetic algorithm is mainly to optimize the parameters of Bayesian core algorithm genetic algorithm at this level. The main optimization parameters include the identified uncertain population size, the crossover rate, and mutation rate of the uncertain population, and the termination threshold of the algorithm is proposed in this paper, in which the corresponding population crossover rate. The rate of variation is mainly processed and analyzed based on adaptive function.

In order to further improve the accuracy of the above Bayesian network structure in identifying uncertain information in metrology and improve the performance of the whole algorithm, this study also optimizes its priority relationship, which is also the further optimization of the core genetic algorithm of Bayesian network in this study. Based on the original priority confirmation, this study reestablishes the logical relationship between different data nodes and defines it as causality. Based on this causality, the corresponding node priority judgment standard is set as shown in

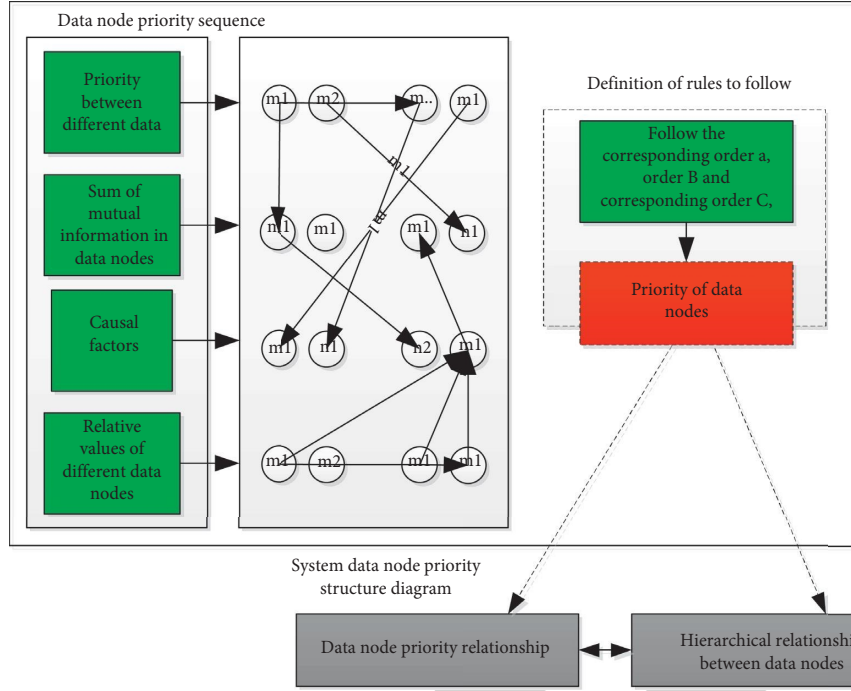


FIGURE 2: Schematic diagram of data priority network structure.

formula (1). The corresponding m in the formula represents the corresponding data sample code, and the corresponding n represents the total number of samples of the whole data node. The corresponding N represents the corresponding data random variable. It can be further seen from the judgment formula that the interference factors in the judgment of causality are deleted in this study, and the causality is calculated and processed based on the corresponding conditional probability. At the same time, the relative causality of nodes in the three dimensions of A , B , and C is fully considered in the formula, and the causal effects caused by their corresponding causality are weighted.

$$xy(m \rightarrow n) = \ln \left[\frac{P(y_{i+1})}{P(n_{i-1})} \right]. \quad (1)$$

Based on this, it can be further concluded that the decision steps of optimizing the priority sequence of data nodes are as follows:

- (1) Step 1. Triggers from a specific node in the specified Bayesian network structure to gradually calculate the causal effect between the node and other nodes in the system.
- (2) Step 2. Substitute the above corresponding causal effect into the judgment formula for judgment processing. When the corresponding node priority order is processed, the corresponding priority judgment rules are as follows: when $xy(m \rightarrow n) > xy(n \rightarrow m)$, the priority of the corresponding node x increases by 1; otherwise, the priority of the corresponding node y increases by 1.

- (3) Step 3. Perform algorithmic traversal processing on all nodes in the whole system until the causality corresponding to all nodes in the system is calculated. Based on this, the priority vector of the corresponding nodes is arranged in ascending order to obtain the corresponding priority order.

Based on the above analysis, this study introduces the priority sequence processing with causality into the traditional Bayesian genetic algorithm and improves and optimizes the four key levels of the corresponding genetic algorithm, so as to form a hybrid uncertain information recognition algorithm. The corresponding algorithm architecture is shown in Figure 4. From the figure, it can be further concluded that the steps of the optimization algorithm in this study are as follows:

- (1) Step 1. Perform priority processing on the corresponding data population to be processed, and perform algorithm traversal processing on all nodes in the whole system until the causality corresponding to all nodes in the system is calculated. Based on this, the corresponding nodes are arranged in ascending order to obtain the corresponding priority order.
- (2) Step 2. Perform iterative analysis based on the processed individual data nodes.
- (3) Step 3. Form the initial population based on the algorithm proposed in this paper.
- (4) Step 4. Encode the population to form the corresponding adjacency matrix, regard the operation of the corresponding adjacency matrix as the operation of the system individual, and finally construct the

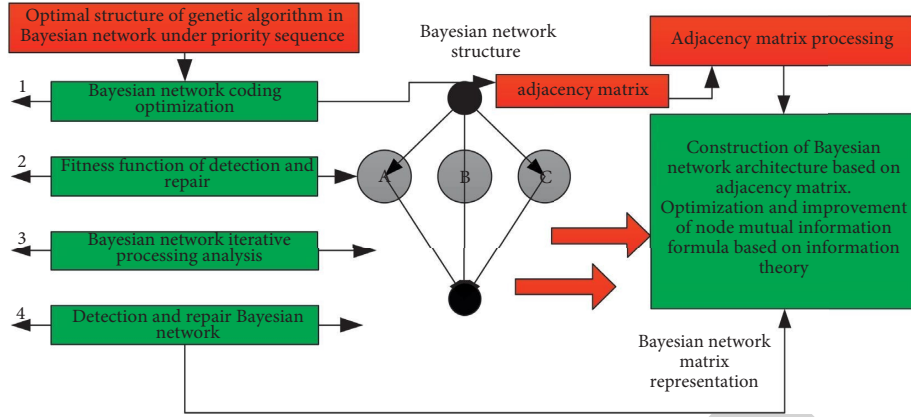


FIGURE 3: Schematic diagram of optimization structure of genetic algorithm in Bayesian network based on priority sequence.

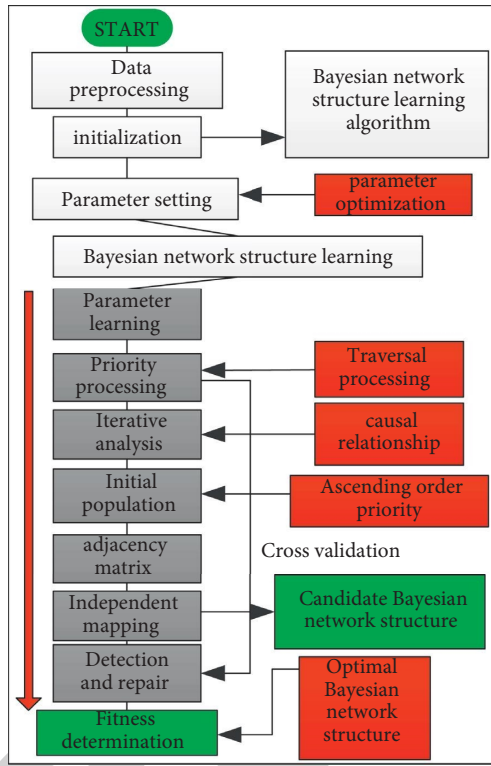


FIGURE 4: Flowchart of Bayesian network structure algorithm based on improved genetic algorithm.

Bayesian network architecture based on the adjacency matrix.

- (5) Step 5. For the data edge in the independent mapping, the corresponding node is retained and removed by determining the corresponding obstacle set. Based on this operation step, the corresponding candidate Bayesian network structure can be further obtained.
- (6) Step 6. For the entire Bayesian network system, detect, repair, and remove the abnormal network structure in the process of population or data iteration.
- (7) Step 7. Determine the fitness of different data nodes in the system based on the fitness function and select the data nodes with high fitness.

- (8) Step 8. Repeat the above process until the optimal Bayesian network structure is found.

Based on the above-improved algorithm, the disadvantages of falling into local optimization and premature convergence of the whole Bayesian network can be further avoided in theory. At the same time, it can further improve the accuracy of the whole Bayesian network in identifying uncertain information.

4. Experiment and Analysis

Based on the above theoretical analysis of the algorithm, this section will experiment based on the convolutional neural network keywords in a large data knowledge base. In the experiment, the algorithm proposed in this study is compared with the Bayesian network under the traditional genetic algorithm. The corresponding experimental data groups are the same group of data, and the corresponding experimental environment is consistent.

For keywords such as convolutional neural networks, network learning processing is carried out based on the algorithm in this study. Based on the improved node priority algorithm and causal effect processing, the corresponding algorithm mainly determines the corresponding semantics and whether the corresponding keywords in the keyword data set correspond. The corresponding learning results are shown in Figure 5. The corresponding data codes in Figure 5 represent different keywords and the frequency of corresponding keywords.

According to the above network learning results of convolutional neural network, the Bayesian network data learning is compared based on the algorithm in this study and the traditional algorithm. The corresponding comparative analysis diagram is shown in Figure 6. It can be clearly seen from Figure 6 that the algorithm proposed in this study is higher than other traditional algorithms in the number of correct edges of data nodes, and in the corresponding average index of redundant edges, the causality proposed in this study and the improved genetic algorithm play an obvious role.

In order to verify the accuracy of this algorithm in identifying uncertain information, this study makes a fuzzy

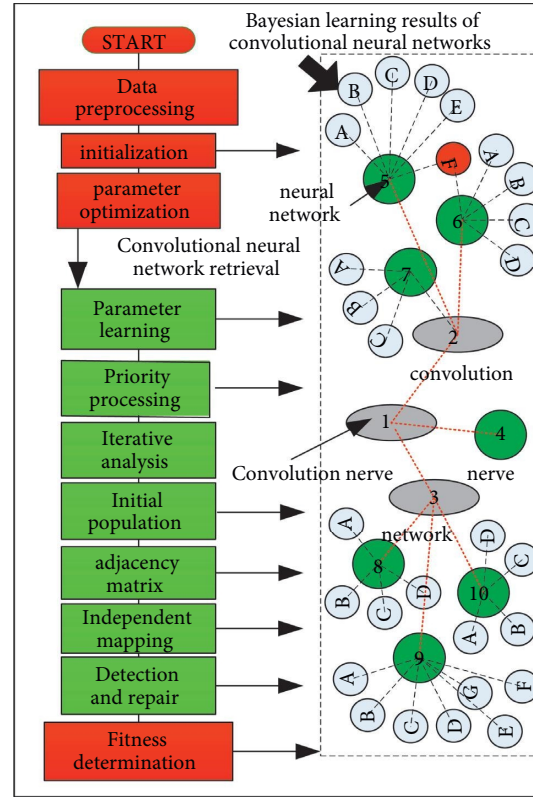


FIGURE 5: Learning result chart.

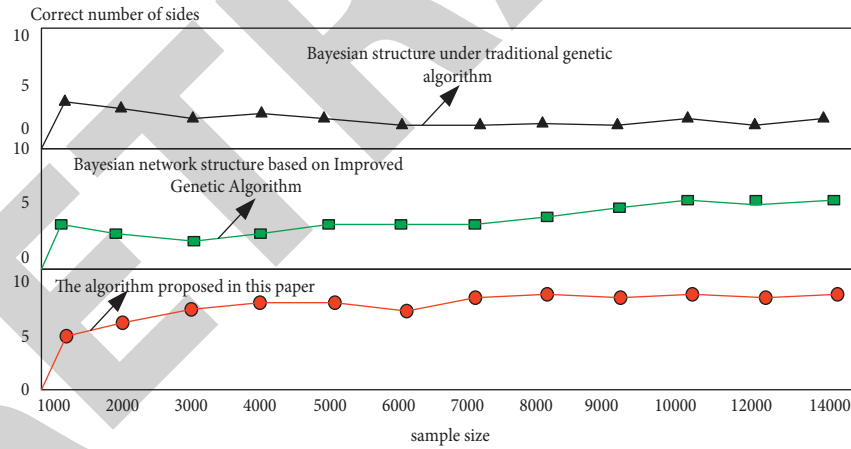


FIGURE 6: Line chart of Bayesian network data learning comparison.

search for the keyword convolutional neural network based on the same database. At the same time, the compared algorithm is the traditional Bayesian network based on the genetic algorithm. The corresponding accuracy and the corresponding algorithm standard deviation are shown in Figures 7 and 8. It can be seen from the figure that the corresponding algorithm proposed in this study is significantly higher than the traditional algorithm in accuracy and standard deviation, which fully reflects the obvious advantages of the improved genetic algorithm and the priority sequence based on causality.

In order to further verify the accuracy of the corresponding algorithm and the fluctuation of standard

deviation under a large sample size, three rounds of new database samples are added to the database of the original experiment, and comparative experiments are carried out based on the new data samples. The experimental results are shown in Figures 9 and 10. It can be seen from the experimental results in Figure 9 that with the continuous increase of database samples, the accuracy of the corresponding algorithm has achieved the effect of continuous improvement. Compared with the traditional algorithm, the accuracy of the corresponding algorithm proposed in this study improves faster, and the overall increase in accuracy of the traditional algorithm decreases with the increase of samples; it can be seen from Figure 10 that the

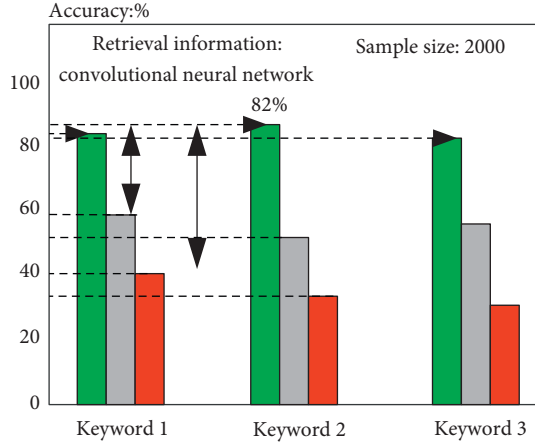


FIGURE 7: Comparison column chart of accuracy of identifying an uncertain information level.

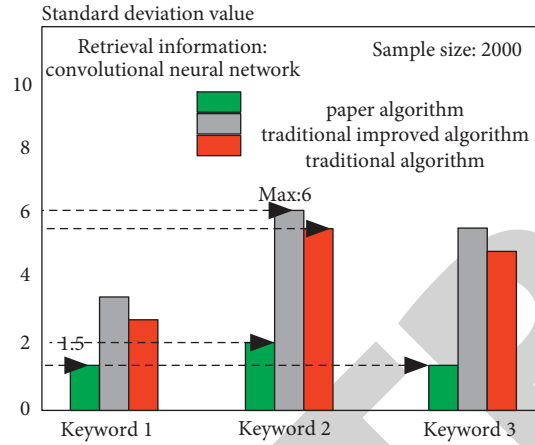


FIGURE 8: Standard deviation comparison column chart for identifying uncertain information level.

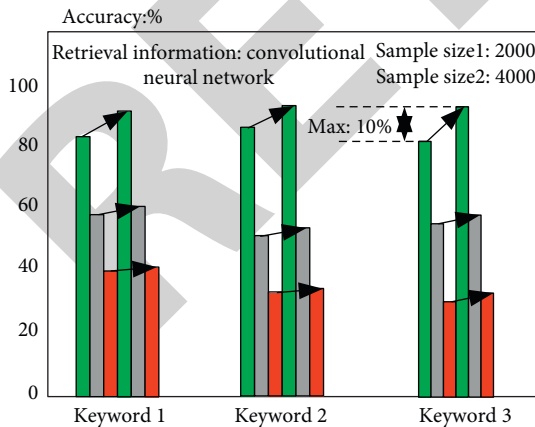


FIGURE 9: Comparison bar chart of accuracy of identifying uncertain information (increase in sample size).

corresponding standard deviation index does not improve significantly with the increase of database samples, but the algorithm proposed in this study still has obvious advantages over the traditional algorithm.

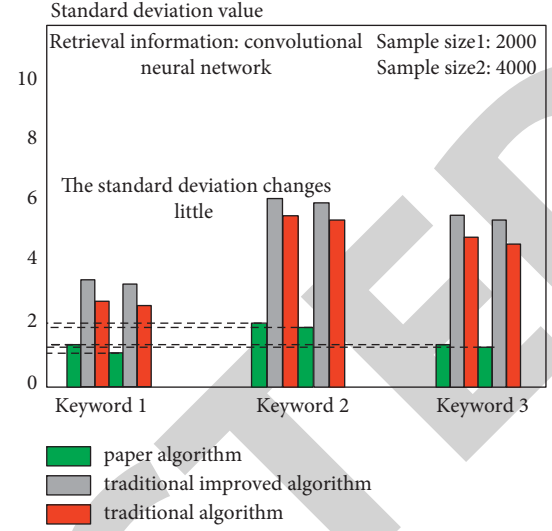


FIGURE 10: Standard deviation comparison column chart of identifying uncertain information level (increase in sample size).

As shown in Figures 11(a) and 11(b), it is a broken line diagram of the overall system performance comparison between the algorithm in this study and other traditional algorithms. It can be seen from the figure that the algorithm proposed in this study consumes less resources at the level of identifying uncertain information, and its corresponding algorithm has higher performance. At the same time, comparing Figures 11(a) and 11(b), it can be seen that with the continuous increase of the corresponding sample size, the performance advantage of the corresponding algorithm is more obvious, and the performance difference with the traditional algorithm is greater.

Based on the above experimental results, the advantages of this algorithm are basically verified. At the same time, it also provides an optimized algorithm for the application of Bayesian network in metrology, improves the recognition accuracy of Bayesian network for uncertain information, and improves the performance of the whole algorithm.

5. Summary

This study mainly analyzes the theoretical points of Bayesian network structure learning and comprehensively analyzes the current theoretical research status of Bayesian network based on the research status of Bayesian network application level. Based on the current application of Bayesian network in metrology, this study adds an adaptive genetic algorithm with causality to the original Bayesian structure, so as to optimize the operation strategy of its structure and quantitatively describe the order of the corresponding data nodes. The corresponding data nodes are arranged in the order of node priority, and the initial architecture of Bayesian network is initialized based on this. Finally, the network is initialized through information reciprocity and data score correction, so as to obtain the final learning results. In this study, the convolution neural network algorithm in a database is used for experimental verification. The experimental results show that the accuracy of the experimental

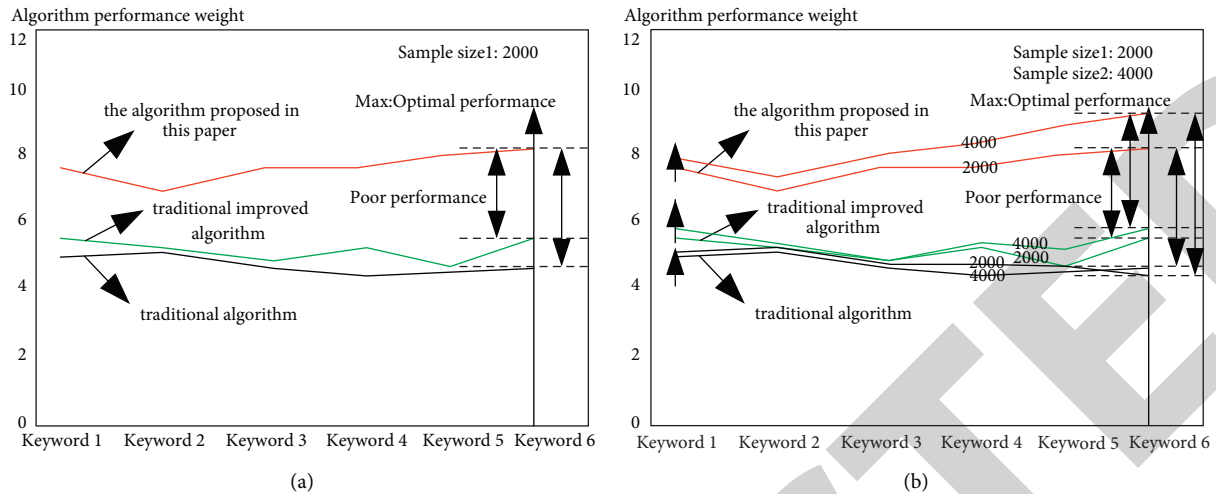


FIGURE 11: (a) Algorithm performance comparison line chart (initial sample size). (b) Algorithm performance comparison line chart (sample size after capacity increase).

results given by the Bayesian network structure proposed in this study is about 10% higher than the traditional accuracy, and its corresponding learning results basically cover the important algorithms, hypotheses, and verification of convolution neural network. From this level, the algorithm proposed in this study has obvious advantages in bibliometrics. This study will focus on the construction of Bayesian network in the case of multiple nodes when the corresponding data nodes increase. At the same time, it will further analyze and study the analysis of Bayesian network in complex cases and its recognition accuracy in metrology [21].

Data Availability

The figures used to support the findings of this study are included in the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

The authors would like to show sincere thanks to those techniques who have contributed to this research. This work was not supported by any funds.

References

- [1] V. Asvatourian, P. Leray, S. Michiels, and E. Lanoy, "Integrating expert's knowledge constraint of time dependent exposures in structure learning for Bayesian networks," *Artificial Intelligence in Medicine*, vol. 107, no. 4, Article ID 101874, 2020.
- [2] M. Velikova, P. J. F. Lucas, M. Samulski, and N. Karssemeijer, "On the interplay of machine learning and background knowledge in image interpretation by Bayesian networks," *Artificial Intelligence in Medicine*, vol. 57, no. 1, pp. 73–86, 2013.
- [3] X. Xie, Y. Liu, Y. Luo, and Q. Du, "Surface water quality evaluation based on bayesian network," *Journal of Coastal Research*, vol. 93, no. sp1, p. 54, 2019.
- [4] Q.-Q. Meng, Q.-X. Zhu, H.-H. Gao, Y.-L. He, and Y. Xu, "A novel scoring function based on family transfer entropy for Bayesian networks learning and its application to industrial alarm systems," *Journal of Process Control*, vol. 76, no. 2, pp. 122–132, 2019.
- [5] E. N. Cinicioglu and P. P. Shenoy, "A new heuristic for learning Bayesian networks from limited datasets: a real-time recommendation system application with RFID systems in grocery stores," *Annals of Operations Research*, vol. 244, no. 2, pp. 385–405, 2016.
- [6] A. C. Constantinou, Y. Liu, K. Chobtham, and Z. Guo, "Large-scale empirical validation of Bayesian Network structure learning algorithms with noisy data," *International Journal of Approximate Reasoning*, vol. 11, no. 3, p. 131, 2021.
- [7] T. Talvitie, R. Eggeling, and M. Koivisto, "Learning Bayesian networks with local structure, mixed variables, and exact algorithms," *International Journal of Approximate Reasoning*, vol. 115, no. 3, pp. 69–95, 2019.
- [8] M. Bartlett and J. Cussens, "Integer Linear Programming for the Bayesian network structure learning problem," *Artificial Intelligence*, vol. 244, no. 3, pp. 258–271, 2017.
- [9] W. Yin, S. Garimalla, A. Moreno, M. R. Galinski, and M. P. Styczynski, "A tree-like Bayesian structure learning algorithm for small-sample datasets from complex biological model systems," *BMC Systems Biology*, vol. 9, no. 1, p. 49, 2015.
- [10] H. Dan, M. Wienreb, and B. Lerner, "Joint maximization of accuracy and information for learning the structure of a Bayesian network classifier," *Machine Learning*, vol. 109, no. 5, pp. 11–21, 2020.
- [11] F. Dondelinger, D. Husmeier, and S. Lèbre, "Dynamic Bayesian networks in molecular plant science: inferring gene regulatory networks from multiple gene expression time series," *Euphytica*, vol. 183, no. 3, pp. 361–377, 2012.
- [12] M. Scanagatta, G. Corani, M. Zaffalon, J. Yoo, and U. Kang, "Efficient learning of bounded-treewidth Bayesian networks from complete and incomplete data sets," *International Journal of Approximate Reasoning*, vol. 95, no. 3, pp. 152–166, 2018.

Retraction

Retracted: Application of Internet of Things Architecture in Intelligent Classroom Teaching Analysis in Colleges and Universities

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Du, "Application of Internet of Things Architecture in Intelligent Classroom Teaching Analysis in Colleges and Universities," *Mobile Information Systems*, vol. 2022, Article ID 4831937, 7 pages, 2022.

Research Article

Application of Internet of Things Architecture in Intelligent Classroom Teaching Analysis in Colleges and Universities

Hongna Du 

School of Marxism, Xi'an International University, Xi'an, Shannxi 710016, China

Correspondence should be addressed to Hongna Du; 2016123865@jou.edu.cn

Received 29 April 2022; Revised 25 May 2022; Accepted 1 June 2022; Published 28 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Hongna Du. 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.

Smart classroom is based on information technology, and its operation, upgrading, and development need technical support. At present, most of the smart classroom teaching adopts traditional architecture, highlighting the characteristics of disciplines, insufficient data processing, and narrow application fields. Based on this, this paper studies and analyzes the application of Internet of things architecture in college smart classroom teaching analysis. Based on the simple analysis of the development of intelligent algorithms and smart classrooms of the Internet of things, this paper constructs a smart classroom system based on the architecture of the Internet of things, transfers it to information-based teaching, introduces an intelligent service platform, and uses intelligent algorithms to mine and cluster data. The core algorithm is improved based on K-means algorithm and grid algorithm to improve the pertinence and effectiveness of the algorithm. Through the simulation results, the improved clustering analysis algorithm can shorten the running time and improve the clustering effect. At the same time, the application test results of the algorithm also show the superiority of the clustering results, which can provide more strategies for later teaching.

1. Introduction

Compared with the Internet of things, it realizes a variety of information interaction functions through the Internet of things [1]. At present, there are many common technologies, such as intelligent technology and embedded technology [2]. In recent years, there have been many researches on the application of Internet of things in learning. It is generally believed that the introduction of Internet of things technology will help to create a learning mood, improve the pertinence of teaching, and realize the intelligent promotion of resources. In the traditional teaching field, it belongs to the factory processing mode and lacks the interaction between teachers and students. This teaching mode is difficult to improve students' innovation ability [3]. The emergence of smart classroom provides new possibilities for the teaching field. Smart classroom applies Internet of things technologies, such as data mining and intelligent analysis, to realize the intelligent processing of teaching, promote more targeted learning contents for teachers and students, and also facilitate the communication between teachers and students [4].

Based on this background, this paper studies and analyzes the application of Internet of things architecture in college smart classroom teaching analysis, which is mainly divided into four chapters. The first chapter briefly introduces smart classroom teaching and Internet of things technology; Chapter 2 analyzes the data mining algorithms and cluster analysis algorithms related to the Internet of things technology at home and abroad, and summarizes the application and shortcomings of the existing algorithms. Based on the simple construction of the smart classroom based on the Internet of things architecture, the third chapter improves the architecture, introduces the learning system, and introduces the trusted algorithm to improve the intelligence. At the same time, in the selection of the core algorithm, it puts forward the improved clustering analysis algorithm to improve the clustering effect. Chapter 4 tests the performance of the improved clustering algorithm proposed in this paper and analyzes the clustering effect and purity. Compared with K-means algorithm and grid algorithm, the improved algorithm shows advantages in running time and clustering effect, which proves the effectiveness of

the algorithm, and applies the algorithm as the core algorithm to the teaching system. Experiments show that through this algorithm, we can get better clustering conclusions and provide more convenience for the next teaching.

The innovation of this paper is reflected in the architecture design and algorithm improvement. In the design of smart classroom architecture, the future algorithm upgrading and improvement are fully considered, and information technology is introduced. The application scenario is not limited to classroom teaching, but also can be applied to evaluation and possible online teaching in the later stage. In the aspect of algorithm improvement, aiming at the shortcomings of mean analysis and grid algorithm, a new algorithm for calculating the threshold function is proposed and applied to the teaching platform as the core algorithm to improve the effect of cluster analysis and provide more targeted teaching and learning strategies for teachers and students.

2. State of the Art

The development of information technology not only brings changes to daily life, but also has a great impact on teaching. In the research and analysis, Xie and others used tableau software for visual analysis, calculated the classroom schedule of the first teaching building and the maximum capacity of movable tables and chairs in each classroom, and discussed the application of class visualization technology in smart classroom [5]. Cicmil and Gaggiotti explained the curriculum design and teaching method practice of RPME at the university level in the project management course, pursued experiential reflective learning, analyzed the MBA curriculum design, and provided PM module according to the perceptual nature of the field of project management theory and practice [6]. Fernández-Caramés and Fraga-Lamas proposed a use case-based method in the research and analysis to teach students and users to perform such audits, and then make the detected available IOT devices more secure. They introduced how to automate the vulnerability assessment of IOT devices through Shodan script [7]. Many scholars also analyze from a technical point of view. Ros and Guillaume in their research and analysis discussed that the expenditure single link standard is powerful and allows to deal with various shapes and densities, but it is sensitive to noise. They put forward two improvement measures to deal with noise, considering the local density to ensure that the distance involves the core points of each group, and the hierarchical algorithm prohibits merging representative clusters exceeding the minimum size after determination [8]. Anees et al. proposed a new, dynamic, self-organizing, and fuzzy entropy-based opportunistic clustering and data fusion scheme (hfecs), which uses the asynchronous work and sleep cycle of sensor nodes to establish opportunistic connections between sensor nodes in heterogeneous clusters. After the cluster is formed, hfecs uses the same technology to perform data fusion at the first level to reduce the redundant information flow from the first level and the second level. Hfecs is superior to the

existing heterogeneous cluster benchmark scheme in terms of half-life, stability period, average residual energy, network life, and packet delivery rate [9]. Om and Jaya proposed a web page prediction method based on two-level matching of weighted support and Bhattacharya distance (WS-BD), which uses weighted support to obtain the sequence pattern of interest. The support filters the sequence pattern obtained by PrefixSpan algorithm according to the frequency, duration, and repeatability of the web page, and clusters the sequence pattern of interest by Bayesian fuzzy clustering based on dice similarity. Experiments are carried out with CTI and MSNBC data to prove the effectiveness of this method. The accuracy, recall, and f measurement are improved by 9.59%, 21.22%, and 10.17%, respectively [10].

To sum up, we can see that there are many pure theoretical studies on intelligent algorithms of the Internet of things, and the improvement strategies are different. However, these studies are rarely applied to the actual field, and all kinds of algorithms also have their own defects, such as long running time and insufficient purity; there may be situations where the results cannot be obtained due to nonconvergence. The relevant research of smart classroom mostly starts from the teaching field and rarely involves the computing field, and the algorithms used are often data mining technology, which cannot meet the increasing demand. Therefore, it is of great significance to carry out the analysis and research of smart classroom teaching based on the Internet of things architecture.

3. Methodology

3.1. Smart Classroom Teaching Platform Architecture. Smart classroom is based on information technology, and its development and upgrading are closely related to the technology platform. In different stages of technological development, the construction of the platform will also focus on different directions [11]. The intelligent classroom teaching platform architecture design adopts the information platform design method, makes use of cloud computing, Internet technology, and big data, and combines mobile terminals with data transmission. The basic architecture is shown in Figure 1. The education platform provides basic information services, covering resources, curriculum design, evaluation system, and learning modules [12]. The network server is used to realize the construction of LAN. The overall construction can be divided into several parts, such as teaching, learning, evaluation, and communication.

In the construction of the platform, in order to make the subject teaching more prominent, we also need to introduce the teaching system into it. In improving the design, we need to highlight the discipline characteristics and increase the resource management platform, covering education management, dynamic resources, question bank, etc. In terms of dynamic resources, in addition to resources, we also need to be able to realize data analysis and evaluation, add communication modules in the teaching content, and fully grasp the learning status of students. In recent years, artificial intelligence technology and big data mining technology have

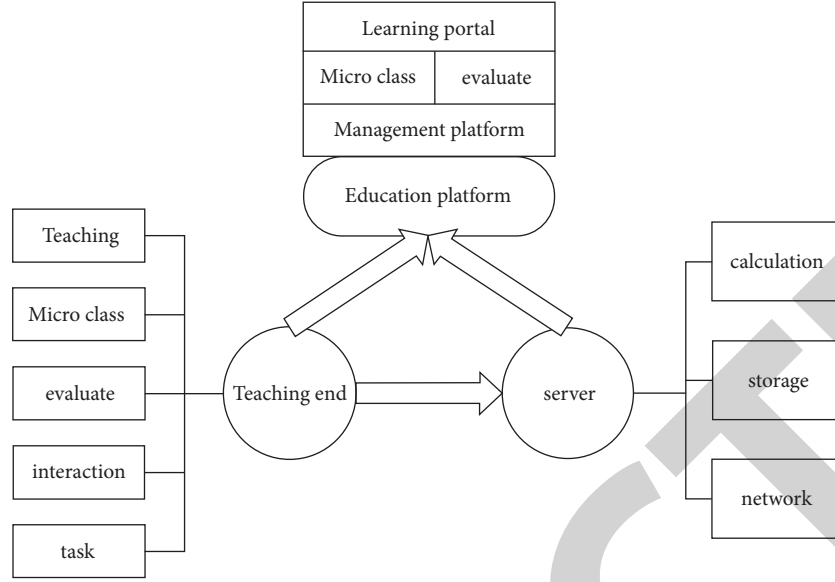


FIGURE 1: Basic structure of smart classroom.

developed rapidly. In the construction of cloud platform, teachers can only use the platform. At the same time, it can be combined with students' intelligent terminals to provide resource services for teachers and students and facilitate the communication between teachers and students. The learning architecture based on Internet of things technology is shown in Figure 2.

JSP technology architecture is adopted in the system design to realize interactive services. This architecture can handle the application logic of resources, and the development is relatively simple [13]. The server adopts Tomcat 5.0, and the background database adopts SQL server to realize data query and update data technology. The functional modules include login module, retrieval module, resource module, counseling module, evaluation module, e-book module, teacher connection module, communication module, background management, etc. There are intersections between resource module and other modules, that is, avoiding the reconstruction of resources. The background management module mainly realizes the management and modification of resource information. At the same time, it can also search resources and maintain the system. The database is designed for some components. At the same time, the database standard is designed according to the components, without storage, so as to reduce the association between tables. This paper adopts SQL database and designs 25 tables, covering grades, course information, member names, and so on.

3.2. Learning System Design. After the platform architecture is basically completed, it is necessary to analyze students' learning needs and provide more targeted teaching for students. At present, there are many researches on this demand, such as data mining technology, cluster analysis, network security, and virtual data technology. [14]. Among various algorithms, cluster analysis can be applied to

personalized learning analysis. Therefore, the core algorithm of this paper adopts cluster analysis algorithm. One of the most important algorithms is data mining [15]. This algorithm examines the similarity of individuals, and the individuals who do not meet the conditions are divided into other groups.

For a given data set, it is divided into different groups according to the similarity, and the formula is expressed as

$$\begin{aligned} C_j | j = \{1, 2, \dots, k\} \\ C_j \in V \\ C_j \cap C_i = \varphi \\ \bigcup_{i=1}^k C_i = V, \end{aligned} \quad (1)$$

where V represents the data set, k represents the number of groups, and C represents the class. Cluster analysis is represented by sequence, and the output is a partition, which can be expressed as

$$\begin{aligned} G_1 \cup G_2 \dots \cup G_k = X \\ G_i \cap G_j = \varphi, i \neq j, \end{aligned} \quad (2)$$

where G_k represents subset. From the concept of cluster analysis, we can see that the algorithm focuses on the similarity between individuals, stipulates some conditions, and divides the individuals with high similarity into a group, in which the individual similarity is the highest. However, the process of cluster analysis is not a simple calculation of similarity, but the distance of feature space [16]. If the two samples are not similar, the dissimilarity is greatly different, and the similarity measurement is reflexive. The formula is expressed as

$$\begin{aligned} \forall x', x \in X \\ \forall x', x \in X. \end{aligned} \quad (3)$$

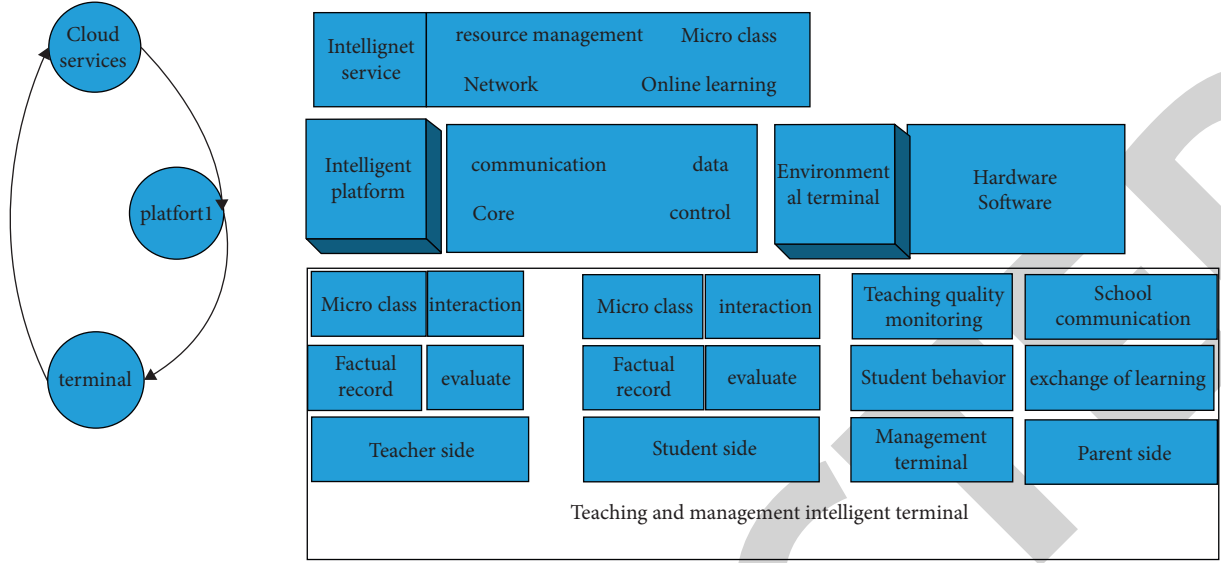


FIGURE 2: Learning architecture based on Internet of things technology.

In general, this metric can be translated into

$$0 \leq s(x, x') \leq 1. \quad (4)$$

Since dissimilarity is not often used as a standard, the measurement standard can be expressed as

$$d(x', x), \forall x', x \in X. \quad (5)$$

Considering the continuity of description value, the degree of dissimilarity can be described by distance. If the similarity of two objects is high, the distance calculation result is small; otherwise, the distance value will be large.

Therefore, scale metrics need to be calculated when describing objects. At present, there are three common distance calculations [17]. Manhattan distance calculation formula is

$$d(i, j) = |x_{i1} - y_{j1}| + |x_{i2} - y_{j2}| + \dots + |x_{im} - y_{jm}|, \quad (6)$$

where $d(i, j)$ refers to the distance of the object piece and x_{im} refers to the attribute of the object. The calculation formula of Euclidean distance is

$$d(i, j) = \sqrt{|x_{i1} - y_{j1}|^2 + |x_{i2} - y_{j2}|^2 + \dots + |x_{im} - y_{jm}|^2}. \quad (7)$$

Minkowski's calculation formula is

$$d(i, j) = \left(|x_{i1} - y_{j1}|^q + |x_{i2} - y_{j2}|^q + \dots + |x_{im} - y_{jm}|^q \right)^{1/q}. \quad (8)$$

where q is a natural number. If q is equal to 1, the result of Minkowski formula is the same as that of Manhattan. If q is equal to 2, the result of Minkowski formula is the same as that of Euclidean distance.

K-means method is a kind of iterative algorithm, which continuously replaces members in the iterative process. The cluster similarity obtained by this algorithm is calculated by using the mean [18]. Assuming that the clustering is

represented by $k_i = \{t_{i1}, t_{i2}, \dots, t_{im}\}$, the mean formula is expressed as

$$M_i = \frac{1}{m} \sum_{j=1}^m t_{ij}, \quad (9)$$

where M represents the mean value, m represents the number of objects, and t represents the distance. Mean algorithm refers to randomly selecting objects, which represent the average value. For the remaining objects, they are divided into different groups according to the calculated distance, and then continue to calculate the average value and repeat until all objects meet conditions. K-means method is most widely used in the current improved methods, and it is also a classical algorithm. However, in the application of this algorithm, the value of K needs to be determined. Therefore, the results obtained by this algorithm are affected by K , with large amount of calculation and low efficiency [19]. At present, there are many improved algorithms, such as the introduction of penalty factor and genetic algorithm. Grid clustering algorithm is also one of the improved clustering algorithms. It has higher efficiency and has no requirements for the shape of clusters. However, it depends too much on the threshold of density. If the value is large, it will lead to cluster loss. If the value is small, it will lead to cluster merging [20].

Although there are many improved methods of cluster analysis algorithm at present, it still needs to be reasonably selected according to the actual situation. Various algorithms also have their own characteristics and application scope, and the improved algorithm itself is also improving. In the research and analysis of this paper, gbkm clustering analysis algorithm is proposed. The algorithm uses iris data to test, and the effect is better in practical application. Based on the improved grid clustering algorithm, this algorithm divides the sample space, then sets the cells, maps them to the corresponding cells, calculates the correlation density, and sets the density threshold. Calculate the data greater

than and less than the threshold to form an intermediate cluster, which does not cover discrete data. Take the center of this cluster as the accident cluster center, calculate the distance, and allocate the data to the corresponding cluster. Recalculate the cluster center data until the algorithm terminates. In this improved algorithm, the biggest difficulty lies in the grid definition itself, which has a great impact on clustering. When meshing with the algorithm, a new function is introduced, which is expressed as

$$\delta = \frac{\sum_{i=1}^n \sqrt{l_i}}{n}, \quad (10)$$

where l_i is the length and i is the natural number. Considering that the grid algorithm is highly dependent on the density threshold, a new strategy is proposed in the improvement, and the formula is

$$\text{Minpts} = \frac{[\sum_{i=1}^N \text{Den}(C_i)^2]^{1/2}}{N}. \quad (11)$$

In the formula, the density value N with the highest density is determined according to the actual situation. This algorithm continuously calculates the cluster center and meets the following conditions:

$$|Z_i^{(1)} - Z_i^{(0)}| \leq \varepsilon. \quad (12)$$

End of clustering. Assuming that the bounded definition domain is represented by A , the n dimension space is represented by S , the S dimension is represented by D , the dimension space formation algorithm inputs data and divides each dimension into different lengths, the space is divided into different units, and the interval can be composed of

$$I_{ij} = [I_i + (j-1)\delta_i, l_i + j\delta_i], \quad j = 1, 2, \dots, p. \quad (13)$$

It is concluded that δ represents the length of the grid element. $\text{Den}(C_i)$ is used to represent the number of data points and define the density threshold, and those greater than the threshold are dense units and calculate the cluster center. The formula is

$$Z_i = \frac{1}{n_i} \sum_{x,y \in k_i} (x, y)^2, \quad (14)$$

where n represents the number and x, y represents different objects.

Using Java language to realize the clustering algorithm, the first step is to define variables, methods, and classes, the second step is to define GetData method, the third step is to divide the data space into multiple grids, and the fourth step is to analyze and display the clustering results. When the system is implemented, the display pages are all in the form of JSP. In addition to completing data classification, cluster analysis also needs to analyze the performance and display after clustering. The database table design covers the structure, grades, and historical grades. The teststru table controls the test paper structure, that is, the proportion of each chapter. The preanalyzed form records students' courses, examination time, and grades.

4. Result Analysis and Discussion

4.1. Performance Analysis. Iris data are used in the experimental performance analysis, which contains 4 features and 150 records. Using grid clustering analysis algorithm can only deal with high-density data, which is prone to point loss, especially for low-density data. The algorithm proposed in this paper will not have this problem and improves the clustering effect. Compare and analyze the algorithm in this paper with the K-means algorithm. After intermediate clustering and iterative clustering, different results are obtained. The clustering results are shown in Figure 3. From the data changes in the figure, we can see that the algorithm proposed in this paper does not change very much, and the clustering is very fast, which shows that this algorithm can simulate the distribution of dense areas, quickly obtain the clustering center, and quickly complete the clustering analysis.

Analyze the clustering effect of the mean clustering method, as shown in Figure 4. From the data changes in the figure, it can be seen that the initial clustering center obtained by this algorithm is large, the center cannot be obtained well, it is constantly changing and unable to fast bracelet, and the number of iterations is increasing. The ideal clustering results should change naturally, and the results should be close each time. The two algorithms are also tested with data sets. The initial clustering centers are compared and analyzed. Each mean method needs to be reselected, and the results are different. It shows that this algorithm takes more time and the amount of calculation is too large. The improved algorithm proposed in this paper can accurately divide the dense area and determine the center as soon as possible, so it can also save time.

Further compare and analyze the running time of different algorithms. The results are shown in Figure 5. From the data in the figure, it can be seen that compared with grid clustering algorithm and mean method, the running time of the algorithm proposed in this paper has significant advantages, indicating that the convergence speed of the algorithm in this paper is faster.

It is generally believed that the higher the purity of the cluster, the better the clustering effect. Assuming that the cluster size is represented by n , the purity of the cluster can be expressed as

$$\text{Purity} = \sum_{i=1}^k \frac{n_i}{n} p_i, \quad (15)$$

where k represents the number of clusters. As shown in Figure 6, there are three algorithms in Figure 6, and the latter two algorithms have higher purity.

4.1.1. Teaching Analysis and Evaluation. Taking the improved algorithm proposed in this paper as the core algorithm, it is applied to the analysis of intelligent classroom teaching. Because there are many contents involved, performance analysis is selected for evaluation. This clustering algorithm can quickly read the corresponding data, cluster, analyze the feature changes, and display the analysis results

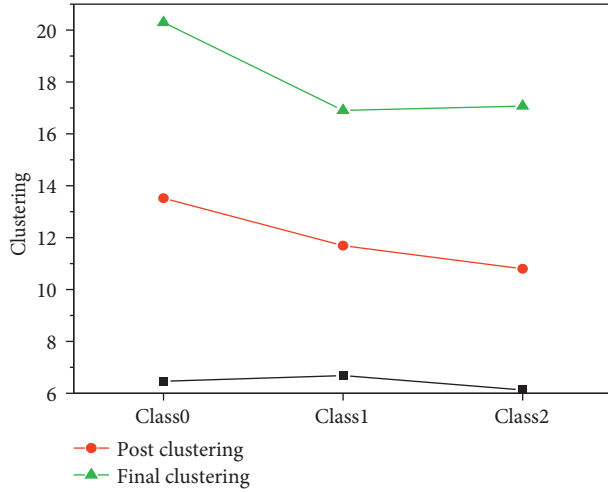


FIGURE 3: Clustering results of this algorithm.

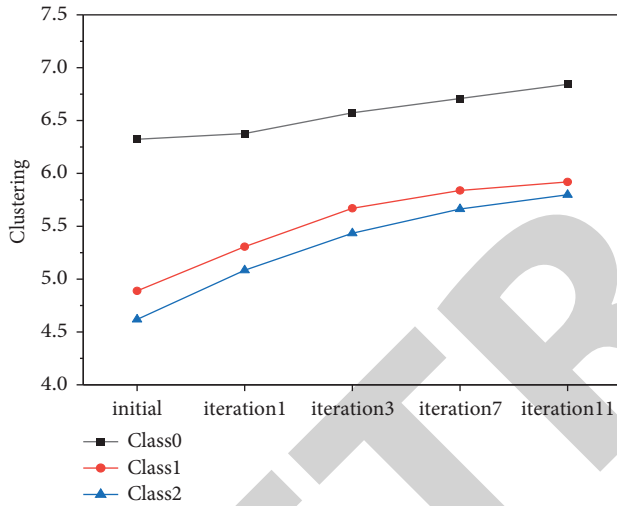


FIGURE 4: Clustering results of K-means.

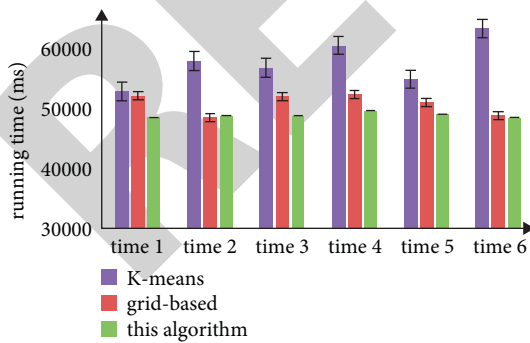


FIGURE 5: Comparison of running time.

on the browser. Store the results in the database to update. By comparing the characteristics of different classes, we can analyze the differences between different classes, as shown in Figure 7. From the figure, we can get the mastery of different knowledge, find out what knowledge deficiencies, and then make more efforts in future teaching.

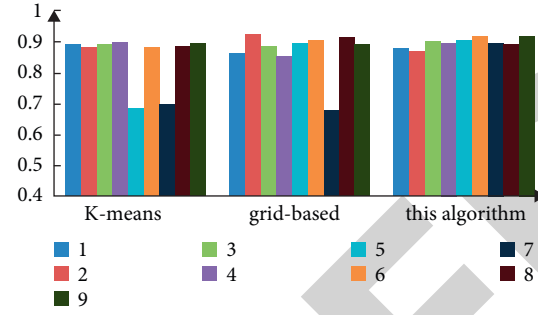


FIGURE 6: Purity comparison.

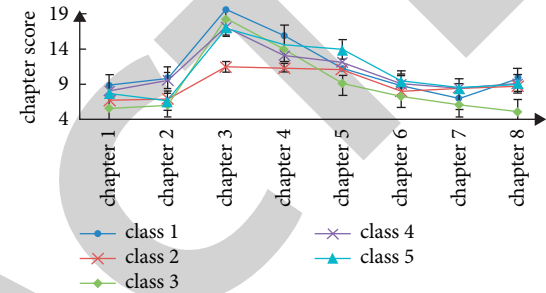


FIGURE 7: Characteristic analysis of each type.

Because of its fast convergence, the improved algorithm can quickly analyze the characteristics of classes and then provide teachers and students with more targeted teaching suggestions and learning strategies. Similarly, this algorithm can also be used in the question setting of the test paper to incorporate the original question setting data into the database. When there is no assessment result, the score of each chapter is determined according to the proportion of each chapter. After the results are obtained, the database is updated to change the proportion of some chapters and sections, so as to provide more improvement strategies for the next question setting.

5. Conclusions

- (1) With the development of big data technology and intelligent technology, the technology and architecture of intelligent classroom are constantly improved. At the same time, it is also accompanied by problems such as technology application, upgrading, and data analysis. This paper studies the intelligent classroom teaching based on the Internet of things architecture, establishes the intelligent classroom architecture, and improves the shortcomings of data analysis and interaction.
- (2) In the selection of core algorithm, aiming at the shortcomings of clustering algorithm and corresponding improved algorithm, learn from the improved algorithm and introduce new functions. Through the simulation test, it can be seen that the algorithm proposed in this paper has better clustering effect and more stable data processing, and can quickly analyze the characteristics of classes.

Retraction

Retracted: Design and Management of Microteaching Mode of Innovation and Entrepreneurship Education in Colleges and Universities Driven by Big Data

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Zhu and Q. Wang, "Design and Management of Microteaching Mode of Innovation and Entrepreneurship Education in Colleges and Universities Driven by Big Data," *Mobile Information Systems*, vol. 2022, Article ID 4689950, 10 pages, 2022.

Research Article

Design and Management of Microteaching Mode of Innovation and Entrepreneurship Education in Colleges and Universities Driven by Big Data

Huirong Zhu ¹ and Qin Wang²

¹Chongqing Jiaotong University, Nanan, Chongqing 400074, China

²Chongqing University of Posts and Telecommunications, Nanan, Chongqing 400065, China

Correspondence should be addressed to Huirong Zhu; 990060004003@cqjtu.edu.cn

Received 11 May 2022; Revised 1 June 2022; Accepted 8 June 2022; Published 28 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Huirong Zhu and Qin 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.

There have been few studies on the quality assessment at the meso- or microlevel in my country's colleges and universities despite the fact that innovation and entrepreneurship (IAE) education is constantly progressing. A new assessment method based on big data is employed in this paper to investigate the design and management of microteaching modes for IAE education and to promote the development of IAE at these institutions while also enhancing the quality of innovative talent training. This paper addresses the urgent need to reform the evaluation system for IAE education. This paper has completed the following work: (1) this paper firstly analyzes the current situation of IAE education evaluation at home and abroad on the basis of literature research and summarizes the current theoretical thinking, methods, and shortcomings of IAE education evaluation. (2) Analyzing the present condition of IAE education assessment, relevant ANN technologies are introduced, and a suitable quality index system for IAE education is created. (3) With the use of big data, we were able to gather samples and data sets for the experiment, and then, we utilized the BP algorithm and the GA-BP algorithm to compare their accuracy in predicting the quality of IAE education, and the GA-BP algorithm has better performance.

1. Introduction

The current economic development is increasingly based on information, knowledge, and technology as the main components of the transformation mode, which continuously promotes the progress of the era of knowledge economy and the era of big data driven by IAE [1]. The advent of the era of knowledge economy marks the continuous strengthening of the constraints of resources and environment, and the investment model and industrial structure under the traditional model are unsustainable due to the characteristics of excessive investment, excessive consumption, and extensive use. It deviates from the low consumption, high added value, and intensive development direction required by the current society [2]. Under the general trend of the era of data technology, we will continue to promote the development trend with innovation as the

main driving force and promote scientific and technological development to achieve progress and innovation. To achieve a more innovative and entrepreneurial society, it is necessary to enhance the IAE skills of the workforce. Since economic growth is now taking place in a spontaneous order, there is not enough innovation and entrepreneurialism in the whole society, nor is there enough training for those who want to be innovators in this new data economy [3]. For this reason, innovation and entrepreneurial education should be enhanced in the face of a societal challenge of imbalanced supply and demand. Colleges and universities serve as a crucial guarantor and basis for the implementation of my country's innovation-driven growth plan and the creation of an inventive nation. The colleges/universities also perform the roles of education, research, and service to the community. As a result, providing quality and quantity of IAE education and training to future business leaders is critical

[4]. Worldwide, entrepreneurship education is on the rise. Western developed nations, such as the United States, continue to ensure the quality of IAE education and utilize educational assessment to halt the deterioration in the quality of IAE talent training. However, my country's IAE education is also plagued by issues such as a lack of financing and a lack of capacity to turn successes in the process of growth. Therefore, since the middle and late 20th century, with the important subject of innovative talent training proposed by "Qian's Questions," after a time of review and standardization, innovation and entrepreneurship education in my nation has moved on to a new phase of systematization and standardization. My nation's economic growth is now approaching a new normal, and the government and the higher education sector are more interested in innovation and entrepreneurial education [5]. It is essential to modernize education via innovation and entrepreneurial education, and it is the only method to build "double first-class." Mass entrepreneurship and innovation will be fostered during the "two sessions" in 2020 as well as the development of an innovation and entrepreneurship assessment system that will serve both to cultivate an innovative school environment and to effectively cultivate inventive talent [6]. Because of this, there is a pressing need to overhaul the assessment system for IAE education. Microteaching mode of innovation and entrepreneurial education is discussed and managed in this paper using big data-driven evaluation method for new-era research, which aims at improving innovative talent training in universities, as well as the development of entrepreneurship in higher education institutions. IAE education reform may also be encouraged via the use of quality evaluations of these programs. Education modernization is a vital aspect of promoting the new requirements of society for talent development in the current age [7]. Since the development of IAE potential relies on the rigorous study on the quality of education that fosters it, this research also serves as an effective tool for encouraging educational institutions to better prepare their students to meet the demands of the marketplace. The quality assessment mechanism for IAE education must be improved to increase education and training quality. The development of a more scientific and methodical approach to IAE education might be encouraged by the construction of a realistic assessment system. As a result of the quality assessment of IAE education in my country, I hope to enhance the quality of IAE education as well as the effectiveness of training innovative talent. I also hope to promote further reform and improvement of IAE education [8]. A strong IAE education assessment system may effectively enhance the fit of the demand for talents in the data economy age based on the execution of the innovation-driven development strategy in the new era.

2. Related Work

In 1945, Harvard University professors advocated that students' inventive capacity and the combined growth of knowledge and ability should be the focus of their education. In addition, the universities of Cambridge and Oxford in the

United Kingdom have always regarded "detecting, excavating, and developing students' potential capabilities and stimulating individual creativity" as their school-running ideas [9]. In 1958, the "National Defense Education Act" promulgated by the US government stated that it is necessary to strengthen the purpose of innovation education to use innovation to enhance national defense competitiveness and the development of modern science [10]. In 1989, Japanese entrepreneurs put forward the "Gap Theory" of entrepreneurship education, which pointed out that there are actually many teaching and market environments. In a similar way, filling the gaps in the market can yield unexpected benefits. Similarly, filling the gaps in entrepreneurship education can yield surprising results. An international symposium on education for the twenty-first century organized by UNESCO in the same year emphasized the need of fostering students' pioneering abilities and inventive spirits via entrepreneurial education. When British colleges and universities began to include entrepreneurship education into their governance and personal development programs for college professors, it had a significant impact. The "Higher Education Society" has specially designed courses related to innovation and entrepreneurship for more than 30 colleges and universities [11]. German colleges and universities pointed out that they should focus not only on the explanation of theoretical knowledge of entrepreneurship but also on the expansion of students' overall thinking mode and the cultivation of relevant quality and ability, gradually infiltrate the relevant knowledge of entrepreneurship in the professional field chosen by the students, and stimulate and guide the students to establish an entrepreneurial spirit. In 1995, the Korean government gradually realized the importance of "innovative elements" and pointed out in the education reform plan that it launched later that the focus of education must be shifted from focusing on cultivating knowledge and memory to focusing on cultivating innovation. The content of university education is no longer just the dissemination of knowledge but should pay attention to the dissemination of technology and creativity [12]. As part of its 2010 education report, the EU urged member states to continue to establish their own entrepreneurial education programs by stating that the EU was open to the idea, encourages collaboration between businesses and universities in the realm of entrepreneurial education, then reforms the autonomous model of entrepreneurship education, and builds a regulatory framework suitable for the development of entrepreneurial enterprises. Universities all over the world are also constantly implementing educational reforms and teaching innovations, expecting the vigorous development of IAE education to live up to the teaching mission of cultivating talents [13]. In 1998, Tsinghua University held an on-campus entrepreneurship competition, which was the first time that the university student entrepreneurship competition was introduced to Asia. Subsequently, the Ministry of Education designated 9 key universities in my country as pilot universities for IAE education. Inventive education was described in 2000 by reference [14] as the educational philosophy and practice of using the principles of creativity to foster students' innovative spirit and skill in

classroom instruction, and as outlined in prioritizing development, education, reform, innovation, equality, and quality improvement were all part of the 2010 Outline of the National Medium- and Long-Term Education Reform and Development Plan. Progress in education may be accelerated by reform and new ideas [15]. Reference [16] pointed out that since 2006, the research on entrepreneurship education in my country has gradually increased, and entrepreneurship research accounts for 1/5 of all entrepreneurship research. However, in terms of total study, there are just a few studies on education quality assessment. As the popularity of innovation and entrepreneurship education grows, academics from both domestic and international countries are more interested in evaluating its quality. IAE education evaluation appeared in the 1990s, and they believe that entrepreneurship education-related courses are the best indicator of quality and that the resources and support given to entrepreneurship education courses can be used to determine their level of effectiveness [17]. Then, a professor further improved the evaluation content of IAE education. He believed that the evaluation indicators mainly include seven aspects, such as courses created, relevant works of educators, social value, and entrepreneurial achievements of students after graduation [18]. In my nation, the quality assessment system for IAE education emerged later than in other countries, although research in this area has risen dramatically in recent years. Scholars first focused on the assessment system's significance and provided several requirements and design guidelines. Reference [19, 20] believes that the construction of the quality evaluation index system of IAE education should follow the five principles of subjectivity, innovation, practice, technological advancement, and team integrity. Reference [21] believes that the construction of relevant indicator systems should follow comprehensiveness, comparability, operability, and scientificity. On this basis, the curriculum, teachers, entrepreneurial environment, and students of entrepreneurship education are set as the first-level indicators of the evaluation index system. Reference [22] gives 40 evaluation indicators more systematically and in detail and divides them into eight categories. According to the article, colleges and universities' investment in IAE education should be taken into account when evaluating the quality and effectiveness of such education. Many academics in the field have also backed this theory. Scholars started to suggest qualitative and quantitative assessment techniques in order to enhance the objectivity and reliability of the evaluation system in the following years. According to some researchers, the evaluation index is determined using the expert survey technique, whereas the evaluation index weight is determined using the AHP analysis approach [23, 24].

3. Method

3.1. Microteaching Mode and Design. "Microteaching" is a new concept in China. The so-called "microteaching" refers to decomposing a complex teaching process into many specific knowledge points or skill points that are easy to master. It proposes teaching objectives for each knowledge

point or skill point and teaches students in a short period of time. The microteaching mode has the following characteristics:

- (1) The teaching time is short. Generally speaking, the teaching time of a knowledge point or skill point is controlled within 20 minutes, preferably 5 to 15 minutes. Typically, an adult's concentration time is 1 hour. However, according to psychological research, in nearly an hour of classroom teaching, the time for students to be able to concentrate and fully understand the teaching content is generally 15 to 20 minutes, and then, they need other stimuli to continue to maintain their attention. Therefore, a corresponding teaching reform has been carried out abroad, that is, a 45-minute classroom teaching is divided into three parts. The first 20 minutes introduce a knowledge point, followed by 5 minutes of relaxation, including classroom discussion, free conversation, learning feedback, etc., and then, a 20-minute knowledge point lecture. Therefore, it is more efficient to generally control a knowledge point of the core value system within 20 minutes.
- (2) The teaching content is small. Generally, a knowledge point or skill point is explained in a microteaching unit, and the learning situation of the knowledge point is reviewed and fed back. After learning this knowledge point, students can have a strong impression of the basic content of the knowledge point.
- (3) The teaching content is refined. Due to the short time of microteaching, the explanation of knowledge points should select the essence of the content and explain it in the most powerful language. In this way, students can master the essence of the course content in less time so as to improve teaching efficiency.

As for IAE education and teaching mode across the country, there is a trend of a hundred flowers blooming as a whole. Another example is that with the help of school-enterprise joint training, practical training courses are set up based on the needs of talents in specific industries. In addition, some colleges and universities adopt the integration model of universities, government, and enterprises. The government provides preferential policies and funds, enterprises build platforms, and schools provide teachers. No matter which mode, its purpose is to cultivate students' innovative thinking, entrepreneurial awareness, and innovative spirit and to enhance students' IAE ability.

3.2. Theoretical Basis of Artificial Neural Network. ANN is a mathematical model established by imitating the structure and function of the human brain. In the sense of a network with a specific topology, the canonical form of the network of neurons is derived. The activity characteristics of the topology are related to any given topology. The network is the same, which marks the official birth of the neural

network. Since then, the ANN has gradually developed, and the application field has gradually expanded. The human brain is the central nervous system of the human body, which is composed of neurons. The transmission of information within the nervous system is achieved through the interconnection of neurons. The human brain can adjust the connections between neurons within the nervous system at the fastest speed according to changes in external information and send chemical signals to other neurons to quickly process and solve problems. Similarly, the ANN composed of artificial neurons can also adjust the interconnection between internal neurons according to external changes so as to have the ability to deal with problems. Since the ANN is established by simulating the human brain, it not only has similar functions to the human brain, such as learning, association, and memory, but also has similar functions to the way of human memory.

3.2.1. Neuron Model. Neural nodes are the basic units that make up a neural network, also called neurons. It is a simplified virtual structure from the basic unit of the biological nervous system, that is, biological neurons. A neural network is formed by connecting neural nodes one after another, and different neurons carry specific data information. Information is transmitted to each other through the connections between nodes, so the characteristics of neural nodes also represent the overall characteristics of neural networks to a large extent. As the basic unit of information processing, neurons have several important functions: excitation and inhibition, plasticity, impulse and potential conversion, spatiotemporal integration, learning, forgetting, and fatigue. It is precisely because of these important functions of neurons that neural networks have excellent performance. Artificial neurons are generally divided into two models, one is an artificial neuron with multiple inputs and a single output, and the other is an artificial neuron with a single input and a single output as shown in Figure 1.

The relationship between the parameters of single input and single output is shown in the following formula:

$$\begin{cases} y_0 = L(x_0), \\ x_1 = A(w, y_0, \sigma), \\ y_1 = f(x_1), \end{cases} \quad (1)$$

where x_0 is the scalar input parameter; y_0 is the output of the preprocessing unit; L is the preprocessing function; A is the activation function, also known as the input function; w and σ are the weight and threshold, respectively, both of which are adjustable parameters; and the threshold is negligible in most network structures; x_1 is the output of the activation function; f is the transformation function of the artificial neuron; and y_1 is its output function.

3.2.2. Classification and Characteristics of Artificial Neural Network. ANNs may be classified into supervised and unsupervised learning networks depending on the learning technique used. Stochastic, competitive, and feedforward

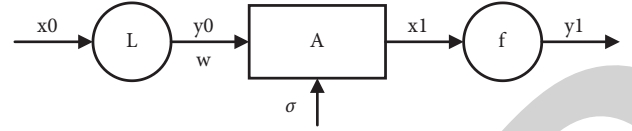


FIGURE 1: Artificial neuron with single input and single output.

neural networks, as well as feedback networks, may be created by combining the network structure with a variety of different learning methods. The following are the major characteristics of a neural network: (1) distributed storage of information. Storing information in different locations can ensure that the network can still output correctly when the network is locally damaged or the input signal is distorted, improving the fault tolerance of the network. (2) Each neuron has both information processing and storage functions. (3) Coprocessing information in parallel. Each neuron of the neural network has the ability to process information independently, and the neurons in the same layer can calculate the output result at the same time and pass it to the next layer for further processing. This feature greatly improves the operation rate of the neural network and has very strong real-time performance. (4) It has the characteristics of self-organization and self-learning. With the increase of training samples and repeated learning, the neural network itself continuously learns and adapts, thereby constantly improving itself and showing a strong self-learning ability. (5) With association storage function: during the training process of the neural network, various influencing factors and continuously adjusted thresholds and weights will be stored in the memory of the neural network. These abnormal data are automatically identified and excluded, and sometimes, several numerical values are added to ensure the accuracy of the output results.

3.3. BP Neural Network and Its Improved Algorithm

3.3.1. BP Algorithm Prediction Steps. BPNN is a feedforward network that includes an input layer, a hidden layer, and an output layer. According to the situation at hand, the number of input layer and output layer neural nodes is defined, whereas the number of hidden layer neurons is often computed using an empirical method. Finally, the output layer receives the information that was communicated from the hidden layer via the transfer function. The status of each layer of neurons only impacts the following layer of neurons throughout the transmission process. A neural network will modify the weights and thresholds of neurons in each layer if the error between the output layer and the predicted value of the target is too big, in order to accomplish the aim of reaching the target. The conventional BPNN's learning procedure is as follows: (1) initialize the weight threshold; (2) input the training samples and calculate the output of each layer through the established network structure and the initialized weight threshold; (3) adjust the weight threshold through error backpropagation; and (4) calculate the error and the mean square error between the output value and the target value, if the convergence conditions are met, end,

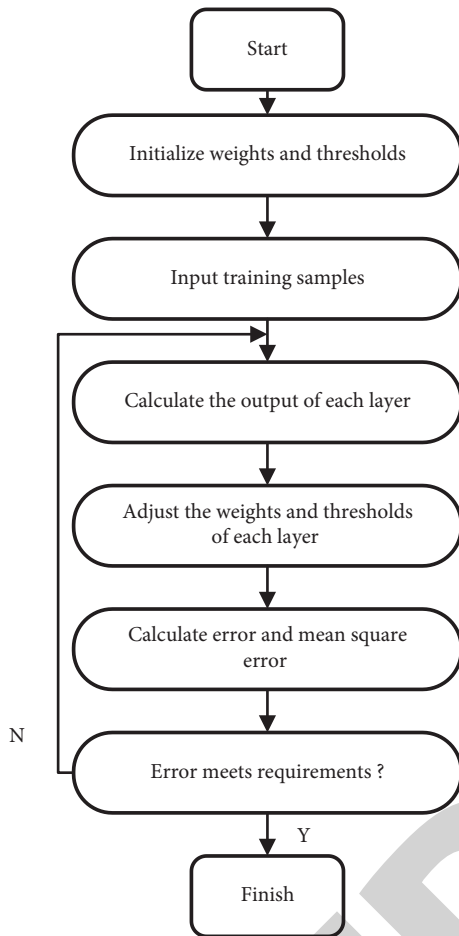


FIGURE 2: Standard BP network flow chart.

otherwise return to the third step, and repeat the error backpropagation to adjust the weight threshold. The standard BPNN process is shown in Figure 2. BPNN has self-learning function, can store and learn a large number of input-output mapping relationships without prior description, and can well adapt to various linear and nonlinear systems, so it is widely used to solve prediction problems in multifactor complex systems.

3.3.2. Genetic Algorithm Improved BP Neural Network. BPNN has the disadvantage that it is easy to fall into local optimum, while genetic algorithm has the characteristics of high efficiency, strong fault tolerance, and global search. Therefore, using genetic algorithm to improve neural network prediction model can overcome the shortcomings of BP neural network optimization, which can avoid local convergence. In Darwin's theory of natural evolution, it is mentioned that when animals and plants mate to select mates, there are two types: artificial selection and natural selection. The difference between the two is as follows: artificial selection is where breeders select plants and animals with desirable traits to mate and leave the best offspring that combine more of the desired traits in a single individual for further breeding. Although natural selection operates in a similar way, it is the selection of mating objects by

individuals of animals and plants according to the characteristics of their environment and other characteristics and leaves those characteristics that lead to acquisition and can be converted into offspring resources. Whether it is artificial selection or natural selection, their mating method achieves "crossover" at the chromosome level to a certain extent, and even chromosomal mutation occurs in the process. In general, both artificial selection and natural selection have a large number of possibilities to be explored in the search space. When exploring this search space, the usual goal is not to find the best individual but to find a set of improvements. Each element has a specified value in the search space, called fitness. The objects of the search are individuals with higher fitness levels. Inspired by Darwin's theory of evolution, scholars imitate the theory of biological evolution, encode the individuals in the problem into chromosome-like strings, search in the search space, and find chromosomes with higher fitness levels to find the solution to the problem. Based on this bold conjecture, model establishment and formula derivation are carried out, and a genetic algorithm is finally proposed. The basic principle of genetic algorithm is as follows. Genetic algorithm is an adaptive optimization search algorithm developed by simulating the genetic evolution process of organisms and the natural law of survival of the fittest. Its biological principle is Darwin's survival law of "natural selection, survival of the fittest, and survival of the fittest." In accordance with the principles of genetics, individuals are selected, crossed, and mutated to update the population and optimize the population. The differences between genetic algorithms and traditional optimization methods can be described in four ways: (1) genetic algorithms encode sets of parameters rather than the parameters themselves; (2) genetic algorithms operate from a set of points rather than a single point; (3) genetic algorithms use yield information, not derivatives or other auxiliary knowledge; and (4) genetic algorithms use probabilistic transition rules, not deterministic rules.

The operation process of the genetic algorithm: the first step is to randomly select an initial population from the solution set containing the approximate optimal solution; in the second step, the individuals in the population are chromosomally encoded so that each individual is a chromosome with specific characteristics; the third step is to place these individuals with chromosome coding in the problem search space and use the value of the fitness function to select individuals with greater environmental fitness; the fourth step is to perform genetic operations such as selection, crossover, and mutation to generate new individuals and participate in the next evolution together with the remaining individuals as a new group. In this way, iterative evolution is repeated until the constraints are met; finally, the optimal solution with the largest fitness value is obtained. Genetic algorithm has high efficiency, parallel processing, global search, and good robustness, so it has unparalleled advantages in dealing with function optimization, combinatorial optimization, and complex nonlinear function problems. It is precisely because of these characteristics of the genetic algorithm that the genetic algorithm develops rapidly and is widely used in various fields.

3.3.3. Basic Steps of Genetic Algorithm. In the process of using genetic algorithm, it is generally necessary to go through chromosomal coding, formation of initial population, calculation of fitness, and genetic operations such as selection, crossover, and mutation.

- (1) **Chromosome Coding:** coding is to use chromosomes in genetics to represent the solutions to be solved in practical problems. Each solution represents a chromosome, and coding will enhance the search ability of the algorithm in the population. There are two main ways of encoding: one is binary encoding for the purpose of using less symbols, and the other is real number encoding for the purpose of easy calculation and high precision. The traditional genetic algorithm uses binary coding for chromosome coding. Due to the large number of independent variables and the long chromosome length, the operation process is complicated, and it is easy to fall into local extreme values and the search efficiency is very low. The real number coding is used in this paper. Compared with the binary coding, the real number coding is not only simple and not easy to fall into the local extreme value but also can improve the operation precision and speed.
- (2) **Fitness Function:** the fitness is the performance of the ability to adapt to the environment. The stronger the fitness, the easier it is to survive in the environmental competition. On the contrary, it is easy to be eliminated by the environment, determine the network structure of the BPNN, initialize the neural network, perform simulation prediction, and get the training error. Because the genetic algorithm searches for the network threshold and weight with the smallest sum of squares of the prediction error, the genetic algorithm can only increase toward the fitness function value. The larger the direction of evolution, the reciprocal of the MSE is selected as the fitness function. The fitness function calculation is shown in the following formula:

$$\text{fitness} = \frac{1}{\text{MSE}} = \frac{1}{\sum (P - Q)^2 / M}, \quad (2)$$

where fitness is the fitness function, P is the expected output, Q is the actual output, and M is the number of individuals.

- (3) **Genetic Operations:** among the simplest genetic algorithms to understand are selection, crossover, and mutation, which are the three fundamental genetic algorithm operators. The genetic algorithm's core is made up of these three operators. They make good use of previous data to make educated guesses about new search areas that might provide better results. Theoretically and experimentally, genetic algorithms have been shown to be capable of strong search in complicated search spaces.

3.4. IAE Education Quality Evaluation System in Colleges and Universities. The objective of this study and the peculiarities of IAE education necessitate the development of a scientific and reasonable quality assessment system for this kind of education, and this paper establishes the following principles for selecting indicators: (1) the principle of scientificity. On the one hand, the selection of indicators, the determination of indicator weights, and the processing of data should be based on scientific principles; in addition, the previous article also mentioned in the literature review that there is overlap and mutual penetration between secondary indicators such as curriculum construction and teaching staff. Therefore, it is necessary to avoid the overlapping of indicators and the loss of scientific principles. (2) The principle of operability. The source of indicator data should be reliable, and the data should be easy to obtain and aggregate. And in practice, it should be able to be directly collect or transform through processable data. In theory, the index data that can be included in the evaluation system but cannot actually obtain relevant data should be screened out to ensure the feasibility of index selection. (3) The principle of simplicity. The selection of indicators is not the more the better. Too many evaluation indicators will bring about difficulties in data selection, increased processing difficulty, crossover, merger, and duplication among indicators. Therefore, in the selection of indicators, this paper tries to choose indicators that are more representative and typical, easy to quantify, and contain a large amount of information so as to reflect the reality of the quality of IAE education.

Analysis of representative successes, such as quality criteria for IAE education quality assessment criteria, is based on educational evaluation theory and educational resource utilization efficiency. Colleges and universities vary in their growth features, as well as in the resources they depend on, the number of professors they employ, and the academic success of its students. The establishment of IAE is based on four aspects: social environment, college environment, teaching team, and student performance. Two secondary indicators are set under the overall social environment target, with relatively small numbers. Because of the limited information related to the social environment of colleges and universities in actual research, it is difficult to collect data, and it is impossible to find corresponding secondary indicators that can be quantified for calculation under the possible primary indicators. Therefore, there are certain unreasonable points in this index system, so it does not reflect the breadth of the concept of social environment indicators in the quality evaluation of IAE education. The constructed index system is shown in Table 1. After the final prediction result is obtained according to the system, the design and management of the microteaching mode is carried out.

4. Experiment and Analysis

4.1. Selection of Sample Universities and Data Sources. Colleges and institutions in city A began teaching students about innovation and entrepreneurship at an early age and saw considerable growth in this area. The benefits of

TABLE 1: IAE evaluation index system of colleges and universities.

| First-level indicators | Secondary indicators | Label |
|------------------------|--|-------|
| Social environment | University-enterprise cooperation rate | X1 |
| | Number of government-related events held | X2 |
| | IAE education funding | X3 |
| | Number of IAE policy documents released | X4 |
| College environment | Number of revisions to talent training programs | X5 |
| | The number of students' entrepreneurial associations | X6 |
| | Number of IAE education lectures | X7 |
| | Number of IAE incubation centers | X8 |
| | Number of IAE courses open | X9 |
| Teaching staff | Number of IAE practice bases | X10 |
| | Number of full-time teachers | X11 |
| | Number of career guidance teachers | X12 |
| | Number of special training for teachers | X13 |
| | IAE course attendance | X14 |
| Student performance | Graduate entrepreneurship program satisfaction | X15 |
| | Student employment success rate | X16 |
| | IAE competition winning rate | X17 |
| | Graduate entrepreneurship rate | X18 |

aggregating educational resources have led to the formation of national institutions that can ensure academic success and provide access to cutting-edge knowledge and expertise. Five National Innovation and Entrepreneurship Education Reform Demonstration Schools currently exist in China. This study uses a technique of horizontal assessment based on the status, level, and efficacy of each university's IAE education and conducts research at three A-class construction universities and two A-class general undergraduate universities. First of all, the five sample universities are all comprehensive universities in terms of functional orientation, and there is no development biased toward a certain subject area. Secondly, at the level of colleges and universities, this article has selected subordinate colleges and universities and municipal colleges; subordinate colleges and universities have their advantages in education funds, educational resources, etc.; and the source of students is relatively good. However, some municipal colleges and universities are in a relatively disadvantaged position due to the limitation of teachers and the level of teaching and scientific research. Many diverse subjects are included in entrepreneurship and innovation education, and each institution has the ability to establish its own. It is thus required to conduct horizontal and vertical comparisons to identify the gaps in growth between colleges and universities at two different levels in many sectors and then provide specific recommendations to address them. Finally, because of the wide scope of IAE education, there are variances among the many professions, industries, and models of IAE in terms of the successes in college and university development. The examples included in this study are from the fields of education and practice related to innovation and entrepreneurship. As a consequence, various fields should be evaluated and compared separately, and the

potential influence on the assessment findings should be taken into account. The data used in this article is highly available, mainly from the 2019–2020 “Undergraduate Teaching Quality Report” released by each sample college in 2020 and the documents published on the official website of the college.

4.2. Prediction Model Establishment

4.2.1. Data Preprocessing. In order to reduce the computational complexity of the BPNN, it is necessary to normalize all input parameters before training to eliminate the influence of the difference in the order of magnitude on the error. The normalization process is shown in the following formula:

$$I' = \frac{I - I_{\min}}{I_{\max} - I_{\min}}, \quad (3)$$

where I' is the value obtained after normalizing the data, I is the sample value of the data table, and I_{\min} and I_{\max} are the minimum and maximum values of the data sample, respectively.

4.2.2. Determination of the Number of Neural Nodes in the Hidden Layer. As a result of this, the number of hidden layer neural nodes has a direct impact on network fitting and simulation prediction accuracy. The network's fault tolerance will be low if the hidden layer's number of neurons is too small, and the proper input and output mapping relationship will not be identified and fit. Increasing the number of hidden neurons will not only increase the number of network iterations but also diminish the network's generalization capacity. The range of the number of neurons in the hidden layer is first calculated using empirical formulae, and then, the network is trained for various numbers to eventually identify the number of neurons. The empirical formula used in this paper is as follows:

$$N = \sqrt{m + n} + i, \quad (4)$$

where m and n are the number of input and output layer nodes, respectively; i is an integer between [1, 10].

According to the number of input and output nodes in this paper, the range of the number of hidden layer nodes is finally determined to be between [5, 15], and the trial and error method is used to conduct experiments, and the results are shown in Figure 3. According to the experimental results, it can be determined that the training effect when the number of nodes is 10 is the best.

4.3. BP Algorithm and GA-BP Algorithm Model Experiment

4.3.1. BP Algorithm Model Experiment. The network simulation runs in the MATLAB environment, and the transfer functions of the input layer, hidden layer, and output layer are tansig function, tansig function, and purelin function, respectively. The number of training iterations is 5000, the learning efficiency is 0.005, and the error target is 0.000165.

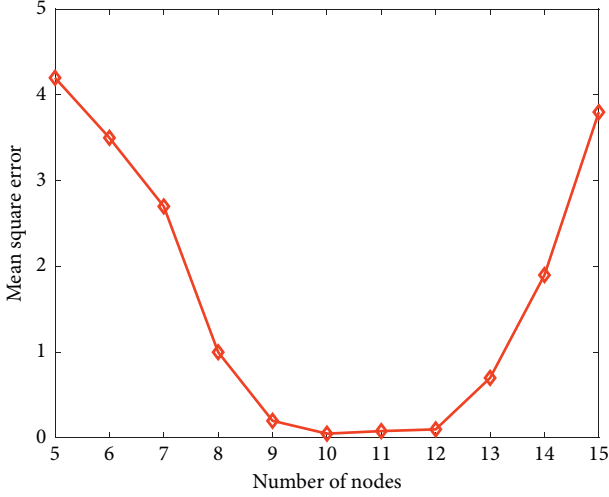


FIGURE 3: The training error of different number of hidden layer nodes.

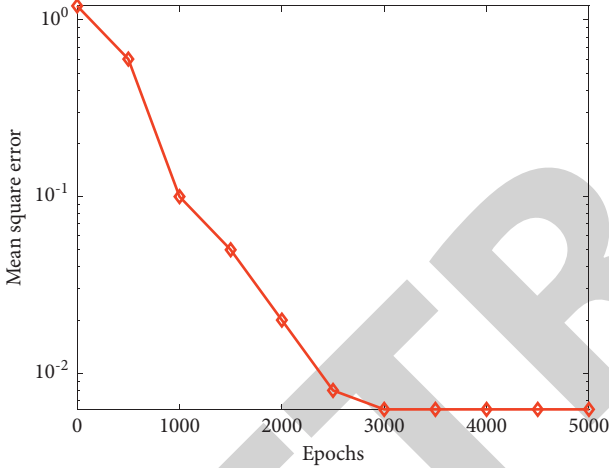


FIGURE 4: BP neural network mean square error diagram.

The mean square error diagram of BPNN is shown in Figure 4. During the 5000 iterations, the minimum mean square error MSE is 0.00625. We can see from the figure that the minimum error has been trained when iterative to about 3000 generations.

It can be seen from Figure 5 that the error between the output of the BPNN and the expert evaluation is very small, and the average error of the 8 experiments is less than the target error, which meets the error requirements, indicating that the BP algorithm model proposed in this paper has a good prediction effect.

4.3.2. GA-BP Algorithm Model Experiment. The transfer functions of input layer, hidden layer, and output layer are tansig function, tansig function, and purelin function, respectively, and the model training function is trainlm. The number of BPNN training iterations is 200, the learning efficiency is 0.01, and the error target is 0.0000165. The maximum evolutionary generation of the genetic algorithm

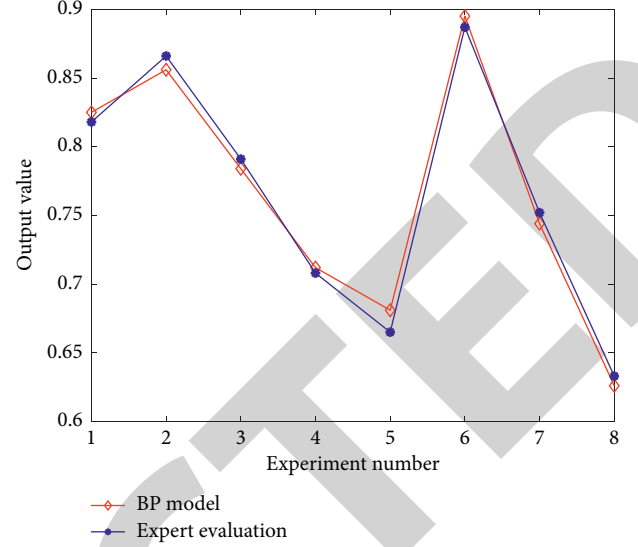


FIGURE 5: Comparison of BP neural network output and expert evaluation.

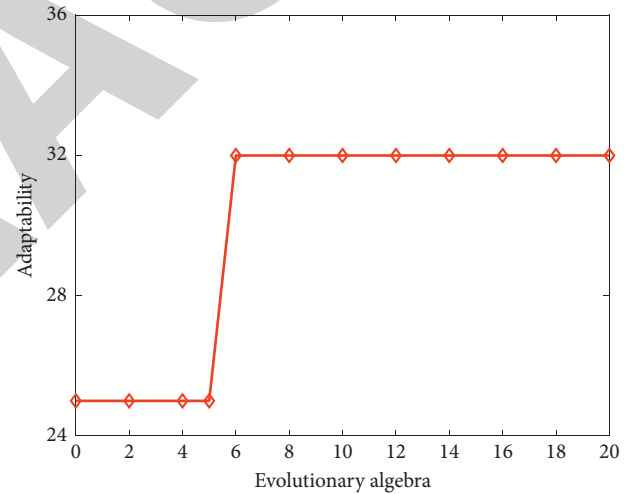


FIGURE 6: GA-BP neural network fitness curve.

is 20, the population size is 30, the crossover probability is 0.5, and the mutation probability is 0.25. For model training, the Levenberg–Marquardt algorithm with high prediction accuracy and less iteration time is selected. Figure 6 shows the fitness curve of the GA-BP neural network. It can be seen that the evolutionary algebra is between 5 and 6, and there is an obvious gradient change, indicating that iterative optimization is being performed at this time. After the sixth generation, the curve is stable and the fitness value reaches the maximum. At this time, the optimal solution has been found, and the mean square error is the smallest.

It can be concluded from Figure 7 that the error between the output of the GA-BP neural network and the expert evaluation is very small, and the average error of the 8 experiments is less than the target error, which meets the error requirements, indicating that the GA-BP algorithm model proposed in this paper has good predict effect.

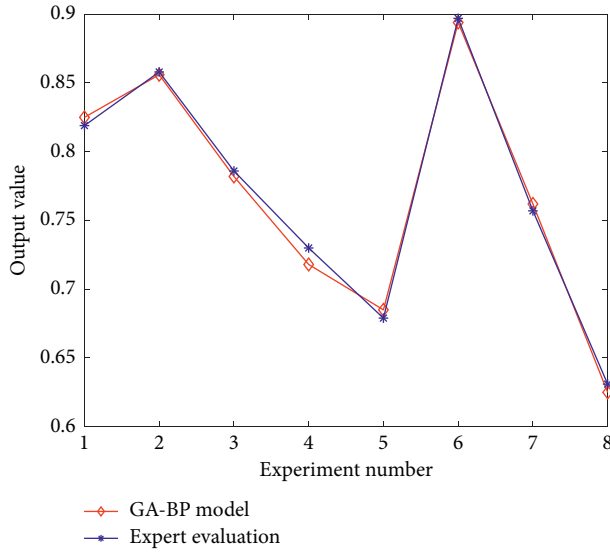


FIGURE 7: Comparison of GA-BP neural network output and expert evaluation.

TABLE 2: Comparison of two models with expert evaluation.

| Number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| Expert evaluation | 0.825 | 0.856 | 0.782 | 0.718 | 0.685 | 0.894 | 0.762 | 0.625 |
| BP model | 0.816 | 0.862 | 0.788 | 0.706 | 0.673 | 0.885 | 0.751 | 0.633 |
| GA-BP model | 0.819 | 0.858 | 0.786 | 0.730 | 0.679 | 0.897 | 0.757 | 0.631 |

4.3.3. *Comparison of the Two Models.* The output results of the two models are compared with the expert evaluation, and the obtained results are shown in Table 2. It can be seen that the GA-BP algorithm model has higher accuracy and better performance than the traditional BP algorithm.

5. Conclusion

It is critical to support efforts to improve the quality of university-based innovation and entrepreneurship education by conducting assessments and conducting research on the current state of the field. This will help guide future efforts to improve university-based innovation and entrepreneurship education. Research on how colleges and universities evaluate the quality of their innovation and entrepreneurship education shows that in order to create a more conducive social environment for the growth of this type of education, the construction of a school-business cooperation platform needs to be strengthened. There must be more investment in innovation and entrepreneurship in college environments, together with a greater emphasis on the curriculum and faculty resources, in order to improve students' innovation abilities and promote the further transformation of innovative successes. Therefore, this paper has completed the following work: (1) this paper firstly analyzes the current situation of IAE education evaluation at home and abroad on the basis of literature research and summarizes the current theoretical thinking,

methods, and shortcomings of IAE education evaluation. (2) Analyzing the present condition of IAE education assessment in certain colleges and universities, relevant ANN technologies are introduced, and a suitable quality index system for IAE education in colleges and universities is created. (3) With the use of big data, we were able to gather samples and data sets for the experiment, and then, we utilized the BP algorithm and the GA-BP algorithm to compare their accuracy in predicting the quality of IAE education in colleges and universities, and the GA-BP algorithm has better performance.

Data Availability

The data sets used during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This work was supported by Key Research Projects of Higher Education Teaching Reform in Chongqing in 2015: Research on teaching reform of entrepreneurship foundation in Colleges and Universities under the situation of "Internet +" (no.: 152023).

References

- [1] P. Robinson and M. Haynes, "Entrepreneurship education in America's major universities," *Entrepreneurship: Theory and Practice*, vol. 15, no. 3, pp. 41–52, 1991.
- [2] K. H. Vesper and W. B. Gartner, "Measuring progress in entrepreneurship education," *Journal of Business Venturing*, vol. 12, no. 5, pp. 403–421, 1997.
- [3] M. Laukkanen, "Exploring alternative approaches in high-level entrepreneurship education: creating micromechanisms for endogenous regional growth," *Entrepreneurship & Regional Development*, vol. 12, no. 1, pp. 25–47, 2000.
- [4] A. Fayolle, B. Gailly, and N. Lassas Clerc, "Assessing the impact of entrepreneurship education programmes: a new methodology," *Journal of European Industrial Training*, vol. 30, no. 9, pp. 701–720, 2006.
- [5] D. G. Sun and X. T. Wu, "An empirical study on the innovation and entrepreneurship quality of engineering majors [J]," *Higher Education Exploration*, no. 05, pp. 124–128, 2016.
- [6] J. Z. Zhang, "On the construction of the evaluation system of innovation and entrepreneurship education in modern colleges and universities[J]," *Education and Vocation*, no. 19, pp. 54–57, 2017.
- [7] H. Oosterbeek, M. Van Praag, and A. Ijsselstein, "The impact of entrepreneurship education on entrepreneurship skills and motivation," *European Economic Review*, vol. 54, no. 3, pp. 442–454, 2010.
- [8] N. Duval-Couetil, "Assessing the impact of entrepreneurship education programs: challenges and approaches," *Journal of Small Business Management*, vol. 51, no. 3, pp. 394–409, 2013.
- [9] J. Du, Z. Ye, F. Peng et al., "Enlightenment of China's university teachers' entrepreneurial awareness for

Retraction

Retracted: A Study of Industrial Convergence in the Context of Digital Economy Based on Scientific Computing Visualization

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] S. Zhou, X. Yang, and Z. Liao, "A Study of Industrial Convergence in the Context of Digital Economy Based on Scientific Computing Visualization," *Mobile Information Systems*, vol. 2022, Article ID 4025875, 12 pages, 2022.

Research Article

A Study of Industrial Convergence in the Context of Digital Economy Based on Scientific Computing Visualization

Shiyuan Zhou¹,^{ID} Xiaoqin Yang,² and Zhixiong Liao³

¹*Institute of Business Administration, Henan University, Kaifeng, China*

²*School of Business Administration, Yellow River Conservancy Technical Institute, Kaifeng, China*

³*Xinxiang Institute of Engineering, Xinxiang, China*

Correspondence should be addressed to Shiyuan Zhou; 10090098@vip.henu.edu.cn

Received 9 May 2022; Revised 9 June 2022; Accepted 14 June 2022; Published 27 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Shiyuan Zhou 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 rapid development of computer hardware and software and the rapid spread of network, the amount of data in scientific computing has exploded. Big data visualization has become one of the important research contents in scientific computing. Against the background of rapid development of information technology and digital technology, the scale of digital economy is increasing day by day, and China's digital economy has ushered in unprecedented progress, and it has become an important force in leading economic development. The development of digital economy promotes industrial upgrading and transformation and facilitates industrial integration, and many traditional industries have given rise to a series of new industries. Scientific computational visualization is a new research discipline with a wide range of applications, including energy surveying, natural sciences, finance, and business. However, as a brand-new discipline, further research is needed in areas such as the application of scientific computational visualization techniques based on the digital economy environment. In this study, we propose a scientific computing visualization approach based on a big data framework for industry convergence analysis in the context of digital economy, which consists of a cloud computing platform for industry convergence in the context of digital economy by integrating neural networks in the platform, and scientific computing visualization by built-in GPU hardware. Traditional research methods for scientific computing visualization are discussed, and algorithms and techniques are classified in terms of the types of data domains studied. Finally, the further development and research directions of scientific computing visualization in the big data environment are given in conjunction with the main theoretical and application results achieved by our group in scientific computing for the field of big data visualization. Scientific computing visualization will not only promote the development and application of cutting-edge information technology, like cloud computing, big data, cyber security, artificial intelligence, computational science, system theory, and so on, but also bring a unique and disruptive development and change to the industrial integration in the context of digital economy.

1. Introduction

With the rapid development of information technology such as artificial intelligence, big data, cloud computing, and Internet of Things, traditional industries and economic development have stepped into the digital era, and digital technology is driving the development and change of traditional industries and economy, and digital economy is also regarded by countries as an important driving force to stimulate economic growth. Under the impetus of digital economy, the solid barriers between traditional industries

have loosened, and different industries collaborate and promote each other, making industrial integration an inevitable trend. At the same time, industrial integration is also abstract: With the development of digital technology, digital economy is regarded by many countries as an important source of motivation to promote economic growth and optimize industrial upgrading. In recent years, China's economy has been in a period of deepening reform and industrial upgrading and change, and General Secretary has emphasized the importance of digital technology and digital economy on many important occasions. This study takes the

digital economy as the entry point, and from the perspective of universality, through the method of logical rehearsal and reasoning analysis, it studies the promotion mechanism of the digital economy in the four directions of technology integration, market demand, scope economy, and external control for industrial integration [1–3]. Key words such as digital economy, industrial integration, and integration mechanism have become important driving forces for the development of traditional industries and economic growth and can effectively promote the optimization and upgrading of economic structure, which is the key to start the “new cycle” of Chinese economy. To sum up, the study of the digital economy on the promotion mechanism of industrial integration can provide certain theoretical value for promoting industrial upgrading and optimizing economic structure. Industrial integration was first proposed in 1963, and technological innovation has gradually blurred industrial boundaries, which in turn has led to industrial integration [4–6]. After the concept of technology-based industrial integration was introduced by means of three overlapping circles (three circles representing computer industry, broadcasting industry, and printing industry), all circles began to pay extensive attention to industrial integration. The definition of industrial integration has also formed a more unified view. Most of them believe that industrial integration is a cross-industry economic phenomenon, which refers to the process of mutual extension, penetration, and integration of different industries or different subsectors within the same industry to gradually form new industries due to technological innovation, demand pull, shared resources, and relaxed regulation. A schematic diagram of the integration of digital economy and multiple industries is shown in Figure 1. The types of digital economy and multi-industry integration mainly include service and agriculture integration, industry and agriculture integration, industry and service integration, and multi-industry integration. Among them, industry-services integration is the most important type of integration.

Scientific computing visualization can use the technology of computer graphics and image processing to display the data information in scientific computing visually and graphically through graphics or images, and it is a method and technology of interactive processing [7, 8]. In today's rapid development of science and technology, the meaning of scientific computing visualization has become more and more extensive, and the visualization of scientific computing also includes the visualization of engineering computing data, and the technology of scientific computing visualization is an emerging technology that has developed rapidly. This technology is closely related to virtual technology and digital technology, and so on. How to process a large amount of data is the difficulty and challenge that people need to face. This study proposes a scientific computing visualization method on the framework with big data for the analysis of industrial convergence in the context of digital economy and gives the further development and research direction of scientific computing visualization in the context of big data. The main contributions of this study are as follows. (1) A scientific computing visualization method for industry

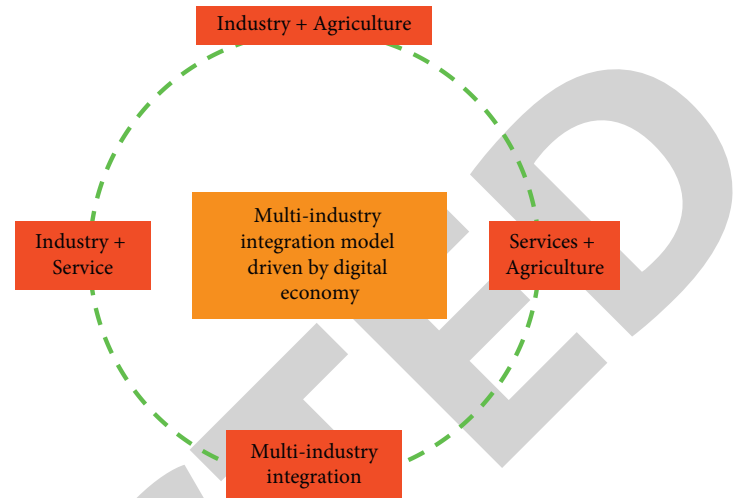


FIGURE 1: Digital economy and multi-industry integration diagram.

convergence analysis in the context of digital economy based on the big data framework is proposed. (2) Traditional scientific computing visualization research methods are discussed, and algorithms and techniques are classified in terms of the types of digital economy fields studied. (3) Further development and research directions for scientific computing visualization of industrial convergence in the context of the digital economy in the big data environment are given, combined with our main theoretical and application results achieved in the field of scientific computing big data visualization.

2. Related Work

2.1. Scientific Computational Visualization. The field of application of scientific computational visualization is very wide, and its applications in the fields of medicine, geological exploration, weather forecasting, and other scientific fields are very numerous. Applications in medicine in the process of disease diagnosis, MRI images, and computer scanning techniques are very widely used [9]. However, for many medical devices, due to the limitations of these devices, only two-dimensional images of the human body are available. For doctors, it is often very difficult to determine the specifics of a patient's condition with the help of two-dimensional images alone, which can cause a lot of problems in treatment. In the process of scientific computational visualization, a three-dimensional form can be obtained from a two-dimensional image, and then a three-dimensional image can be obtained through computer assistance. Based on this, doctors can then perform surgical treatment of the patient's lesion, which becomes much easier with the aid of computer simulation. For example, in children, dysplasia is a disease with a high incidence, and it is often prone to some errors when corrective surgery is performed. If a three-dimensional image of the hip joint is obtained by computer construction with the help of visualization technology, it is possible to perform computer simulation of the cutting site and shape [10]. Before surgery, the best surgical plan can be

implemented after computer simulation of multiple options.

Application in Geological Exploration. In China, the search for oil deposits is a long-term strategic task. The search for oil deposits cannot be done without geological exploration techniques. In the process of searching for oil deposits, with the help of geological exploration, we can better understand the geological structure, discover oil-bearing structures in time, analyze logging data, understand the stratigraphic structure, and clarify the reservoir situation so as to measure the number of reserves and exploration value [11]. In the process of geological exploration, a large amount of geological data and logging data can be collected, which are unevenly distributed, so it is difficult for us to analyze them by paper and pen. With the help of visualization techniques, we construct contour surfaces and contours that help professionals to process the raw data by showing their ranges and movements, using different colors to represent the parameters and relationships [12–14]. Through the application of this technology, the volume of operations will be significantly reduced and will also save money and increase the efficiency of finding oil deposits, which will be of great benefit to the economic efficiency of our oil. The science and technology visualization application is shown in Figure 2.

Application in Weather Forecasting. In weather forecasting, the accuracy of weather forecasting is greatly related to the calculation and processing of data. Through the visualization of scientific calculations, weather forecasters are able to transform data into graphic images, and by displaying these images on a computer screen, it is possible to make isobars, isothermal surfaces, and potential vortices visible, while the size and direction of storm areas and winds can also be displayed [15–17]. In this way, forecasters are able to make weather forecasts more accurate. In addition, after processing the weather monitoring data and calculation results, the global temperature, pressure, and rainfall distribution can be displayed in front of the weather forecasters through images, making it easier for forecasters to predict the weather conditions. The application of molecular model construction to the observation of complex chemical substances through interactive graphical generation techniques originated in the 1960s. Currently, the technique is widely used in academia and industry. With the aid of scientific computational visualization techniques, the construction of molecular models is transformed. Previously considered complex by a wide range of researchers, this method is now one of the very important methods for analyzing and designing molecular structures. For example, scientific computational visualization techniques, when combined with computers, allow for the construction of highly complex molecular structures.

Application in Computational Fluid Dynamics. When designing the shape of objects such as aircraft, it is important to take full account of the effects of the environment in which gases and liquids move at high speeds. **Application in Finite Element Analysis.** Finite element analysis is a numerical computational method introduced in the 1950s [18–20]. Finite element analysis is very widely used in structural

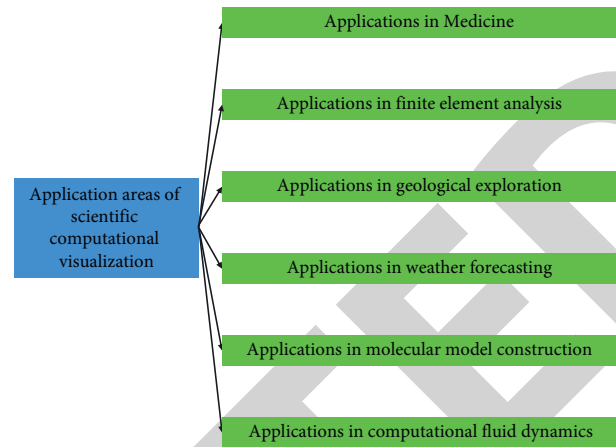


FIGURE 2: Schematic diagram of the application of science and technology visualization.

analysis. This method is one of the powerful tools in computer-aided design and has been widely used in aircraft design and mechanical product design, and even in stress analysis of building structures. From a mathematical point of view, finite element analysis is able to decompose the object of study into multiple subunits. Based on this, the results are obtained through the solution of partial differential equations.

2.2. Digital Economy and Industrial Integration. With the development of digital economy, digital technologies such as big data, cloud computing, artificial intelligence, and so on are occurring in different industrial fields with extensive penetration and application, such as vehicle networking, smart city, unmanned supermarket, smart logistics, and so on. Digital technologies have become the key and universal technical means for different industries, which in turn form the technical integration between industries [21]. Technology fusion will gradually eliminate the technical barriers between industries, make the technology and process between different industries gradually homogenize, substitute, or correlate, realize the related technology and process widely used in the secondary and tertiary industries, and then change the technical characteristics of products and services and the way of value realization, prompt the original industrial sector to replace, and finally blur the boundary between different industries and form the fusion between different industries. At the same time, digital technology is widely used in the collection, processing, transmission, and storage of information. On the one hand, digital technology gradually integrates independent information dissemination forms, such as TV, telephone, fax, and network into one; on the other hand, digital technology digitizes different information carriers, such as text, image, audio, and video, making information structure change and giving birth to new information platforms and new ecology of traditional enterprises' phantomization [22]. The new platform and new ecology prompt traditional enterprises in the supply chain, research and development, production, sales, after-sales and other links of continuous synergistic development, and

enterprises in different industries make full use of their relative advantages, integration and configuration of resources, technology, and so on, adjust the original production cooperation and business services, change the traditional industrial organization form, and develop new industrial models and business models to achieve the integration of different industries.

The digital economy is conducive to the realization of scope economy. The net income obtained by enterprises through cross-industry cooperation is called scope economy. The promoter and main body of industrial integration is enterprises, and the nature of enterprises is to chase profits, and only when enterprises can obtain net income through cross-industry operation and make their profits increase, enterprises will choose cross-industry operation and thus promote the integration between different industries. Under the role of digital economy, many production factors of enterprises have been digitized, and the application of digital technology has improved the supply chain of enterprises, which has lowered the supply cost of enterprises. At the same time, the digital economy has given rise to personalized and diversified demands from consumers and the market, driving enterprises to diversify their products and services and business methods and pursue economies of scope. Driven by both cost and demand, the economies of scope brought by the digital economy can strongly promote enterprises' cross-industry operations and industrial integration [23].

3. Methods

3.1. Model Architecture. The macroeconomic visualization decision support platform is built from data mining and analysis to knowledge understanding and then to the valorization and wisdom of data resources, providing a general, open, dynamic, and all-round data deep integration auxiliary decision support model with flexibility and scalability. The overall framework of the platform is shown in Figure 3. The proposed big data platform consists of display module, cloud network, data fusion features, and database.

3.2. Technical Support

- (1) The metadata system throughout the whole process establishes metadata systems, such as indicators and codes based on the actual needs of the business, organizes indicator data by the data resource construction link, builds thematic analysis through the current economic hotspot analysis service management function, selects data analysis templates, circles the scope of indicators, and finally presents data analysis visualization services, which can switch indicators, codes, and other metadata. Through this kind of analysis and trial calculation, we can explore data application and realize visualization scenarios.
- (2) The metadata system is the basis of data "resuscitation" to form the data resource system. The fundamental purpose of "resuscitation" is to prepare

data on different business objects, business entities, and business elements, so as to use the metadata system for unified organization and management, realize the correlation application between data, and "assemble/invoke" the corresponding data instances (data resources) through resource management means. The corresponding data instances (data resource system) and service instances (service resource system) are designed and implemented on this basis so as to bring better applicability, scalability, and configurability for the deep integration of data and business.

- (3) Data visualization to knowledge visualization: data visualization is technically more advanced method while knowledge visualization analysis is built based on data visualization, combined with business understanding, data perception, interactive operation, exploratory analysis of the impact of business changes on data, and prediction of future data changes. The data visualization technology used in the construction of this platform is mainly to organize the structured or unstructured data with the help of graphical means and present them in the form of graphics plus data coexistence, from time and space dimensions, so that users can understand the data changes and analysis of key analysis elements to achieve the effect that a picture is worth a thousand words.

3.3. Technical Realization. The full name of J2EE is Java 2 Platform Enterprise Edition, and as a whole, J2EE is the industry standard for developing enterprise-class applications using Java technology that can be used for big data platform development. The system construction takes into account the economic and social benefits and adopts an evolutionary construction method under the condition that the demand and effective technology are fully analyzed. The results of this phase plan the technical architecture of the platform on the basis of the first phase construction. The platform as a whole adopts J2EE standard technical architecture, carries out appropriate extensions, and integrates big data application, artificial intelligence, visualization, and other technologies to realize data visualization to knowledge visualization iteration.

- (1) *J2EE Standard Technical Architecture.* J2EE has the features of fully integrating existing resources, supporting efficient development and heterogeneous environment, and so on. The main technical tools include ETL synchronization tools, import of database DMP files, and processing of CSV-like structured data files. Data layer: This system plans the technical framework of business big data storage and service and uses big data processing technologies, such as HBase, to handle unstructured data, mass data storage and management, and also uses graph database to handle the relationship between data and pictures to build a basic-level knowledge graph application. Data access layer: The data access layer is

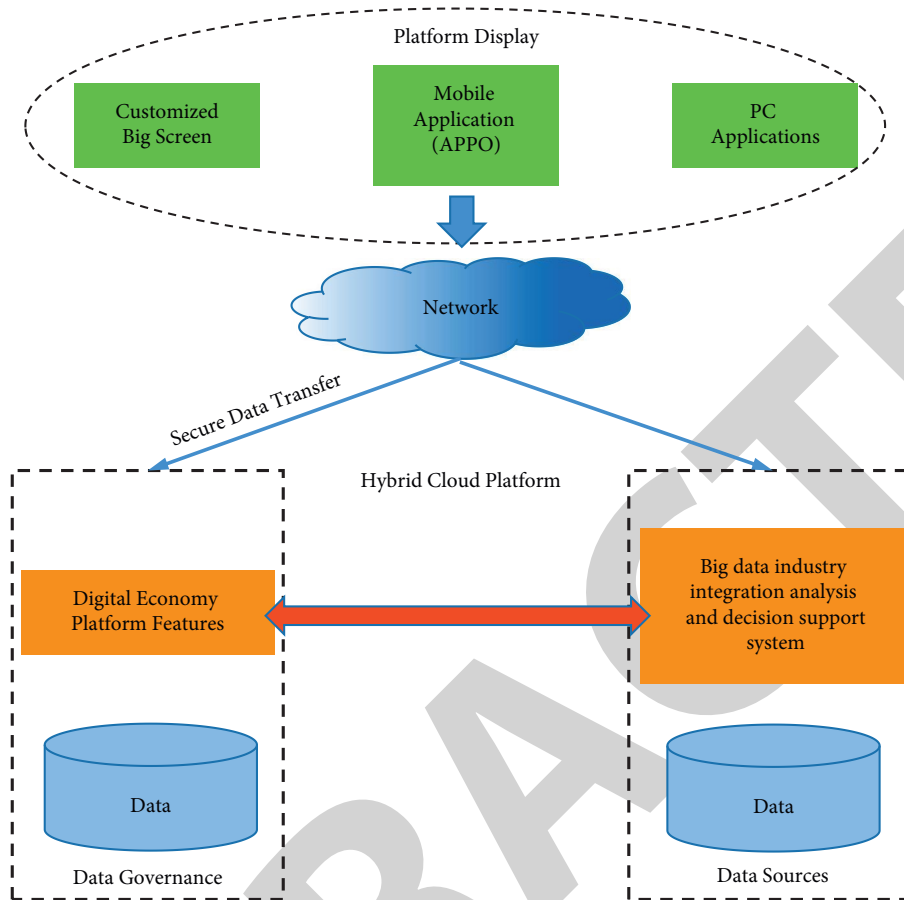


FIGURE 3: Schematic diagram of the model architecture.

the link between the business logic layer and the data layer, realizing the storage and reading of data. The system designs a unified data access interface, which supports both Spring JDBC way to interact with relational database and plans data access under the big data framework. Business logic layer: The business logic layer is responsible for system business logic control and processing of inputs during system interaction. The system is designed with business service management, computing resource services, unified resource scheduling, and third-party system interface modules to ensure the flow of business services, meet the needs of data computing, realize the scheduling of internal and external resources, and serve the third-party system interface requirements. Presentation layer: The system presentation layer design not only adopts mainstream UI frameworks, including Bootstrap, Framework, and jQuery, but also applies GIS presentation services and data presentation components to provide friendly support for business visualization and enhanced analysis page support.

- (2) *Key Technology: Big Data Technology.* It aims to use the data involved with a certain scale, complex frequency, mixed relationships, dynamic and continuous, and variable, to achieve data capture,

storage, distribution, refinement, integration, and analysis within a reasonable time and to extract valuable analysis points from them through scientific calculation methods for assisting and optimizing decision-making. The features are classified according to the learning mode, learning method, and algorithm. The knowledge graph connects all the different categories of information together to obtain a relational network, providing the ability to analyze problems from a “relational” perspective. Lightweight middleware DT technology: DT uses java, Python, R language, and other development tools to integrate Hadoop, HBase, Spark, Neo4j, ETL, NLP, and other big data technologies and applications to provide a common decision support model. With lightweight metadata, business data from different fields, different industries, different regions, and Internet big data, it continuously enriches decision support data resources, provides a variety of means such as derivative calculation, aggregate processing, indicator feature extraction, and so on, realizes flexible topological transformation, on-demand processing, and deep integration of data, and uses a variety of data analysis mining algorithms, such as regression analysis, correlation analysis, clustering analysis, and spatial feature analysis. It uses various data analysis and mining algorithms, such as

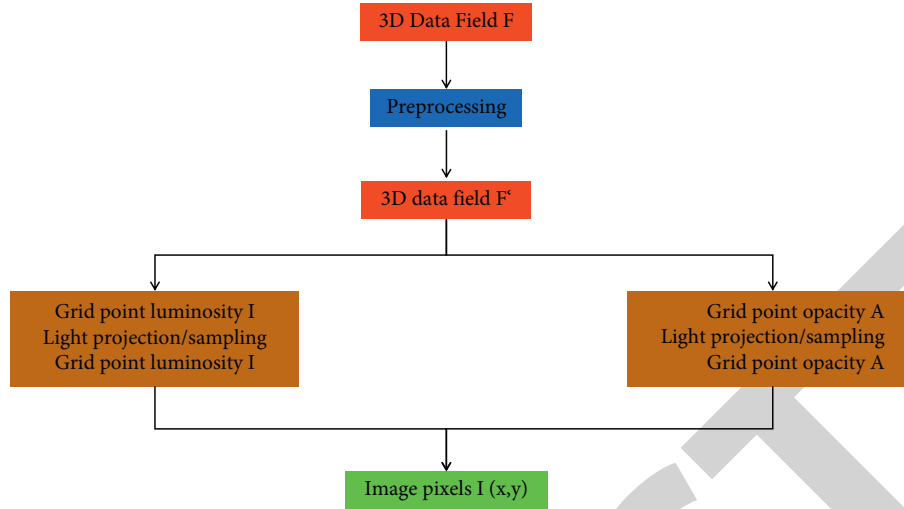


FIGURE 4: Schematic diagram of the scientific and technical visualization process.

regression analysis, correlation analysis, clustering analysis, spatial feature analysis, and visualization means, such as reports, graphics, and infographics, and relies on various decision-making resources, such as indicators, algorithms, models, data, and knowledge that are comprised of business-oriented combining.

3.4. Visualization for Scientific Computing. The study of visualization is divided into two main parts: visualization tools and visualization applications, and the process of visualization for scientific computing (ViSC) is a very important aid in the analysis of natural phenomena to the model building process. The steps of the visualization process can be divided into four parts, namely, “filtering-mapping-mapping-feedback” virtual environment. ViSC is divided into three aspects: visualization of 3D data field, visualization of engineering design, and virtual environment, which correspond to three processing methods: tracking, postprocessing, and driving. The following is a study of the contour method and the body drawing method.

Contour Method. The contour method is a visualization method for two-dimensional planar data fields, and its drawing steps can be divided into the following three points: first, the intersection of each grid cell with the contour is calculated; then, the intersection of the contour within that cell is connected with a line segment; and finally, the collection of the abovementioned line segments constitutes the contour in that grid. The intersection of the grid cell and the contour is calculated mainly by calculating the intersection of each cell edge and the contour, which can be calculated by the vertex determination method and the interpolation method on the edge. Set the value of the contour as F_b ; if $F_i < F_b$, then the vertex is “-”; if $F_i > F_b$, then the vertex is “+.” If all four vertices of the cell grid are “-” or “+,” then there is no contour in the cell of the grid; otherwise, for two vertices with “-” “+” cell edge using the interpolation function to

calculate the intersection of the equivalence line. Grid cell contour line connection diagram: The body plotting method is to traverse the entire data field, resample the data field, and synthesize the sampling results. Body plotting algorithms are divided into two main categories: ray tracing method and projection imaging method. The projection imaging method is to project the impact of all voxels of the object onto the imaging surface and then to realize the color of each pixel through certain synthesis methods according to the iterative order of the voxel impact on each pixel. The main drawing steps can be divided into three steps: “voxel traversal-voxel decomposition-projection and synthesis.” The scientific and technical visualization processing flow is shown in Figure 4.

By studying the contour method and body drawing method, we can conclude that the drawing speed of the image depends on the choice of the algorithm design and the hard requirements of the machine.

3.5. Analysis Model of Digital Economy and Industry Integration. The development and integration of digital economy industries are influenced by both the internal digital economy resource allocation and other external factors, such as multiobjective conditions in the context of digital economy. The economic system input vector has many dimensions and complex influencing factors. The data of the economic system are highly nonlinear and there are complex coupling relationships among the components of the input vectors. The economic system is a typical “black box” model, and there is no clear expression for the interactions between the data. The data of the economic system tends to grow year by year. Due to the above characteristics of the economic forecasting problem, it is difficult for general mathematical methods to effectively forecast the economy with multiple inputs and outputs. First, we determine the structure of the neural network acting on the digital economy industrial system in the context of digital economy, including the number of layers of the network, the nodes of neurons in the input and output layers, and the

number of training samples and test samples. The relationship between the implicit layer and the output layer is as follows:

$$\begin{aligned} h_j &= g\left(\sum_{i=1}^n w_{ij}x_i + \delta_j\right), \\ y_l &= g\left(\sum_{j=1}^k v_{jl}h_j + \theta\right), \end{aligned} \quad (1)$$

where $g(\cdot)$ is the transfer function and the Sigmoid function is used, $g(x) = 1/(1 + e^{-x})$. The neural network can fit the arbitrary many-to-many mapping relationship well within the range of computational power allowed. It is better than taking regression analysis to approximate the effect. The fitness function is as follows:

$$\begin{aligned} f &= \frac{1}{E}, \\ E &= \frac{1}{2} \sum_{k=1}^M (y_k - \bar{y}_k)^2, \end{aligned} \quad (2)$$

where M is the number of training samples, \bar{y}_k is the expected output value of the k th node of the network, and y_k is the actual output value. And the selection operation is to select the good individuals from the population

$$P_i = \frac{f_i}{\sum_{i=1}^N f_i}, \quad (3)$$

where N is the size of the population, and the smaller P_i is, the more likely the corresponding individual will be selected. The expressions of adaptive crossover probability P_c and adaptive variable probability P_m are as follows:

$$\begin{aligned} P_c &= \begin{cases} P_{c1} - \frac{(P_{c1} - P_{c2})(f' - f_{avg})}{f_{max} - f_{avg}}, & f' \geq f_{avg} \\ P_{c1}, & f' < f_{avg} \end{cases}, \\ P_m &= \begin{cases} P_{m1} - \frac{(P_{m1} - P_{m2})(f - f_{avg})}{f_{max} - f_{avg}}, & f \geq f_{avg} \\ P_{m1}, & f < f_{avg} \end{cases}. \end{aligned} \quad (4)$$

Using the training samples, the weights are adjusted by the training function until the target error of training is satisfied. The linkage weights and thresholds between the nodes of each layer of the neural network can precisely express the strong coupling relationship between the factors in the economic system that intertwine and influence each other. The neural network can determine the weights and thresholds of the network with only a small number of training samples for the analysis of industrial integration in the context of digital economy, and the calculation is simple, fast, and reliable. It can fit any many-to-many mapping

relationship very well. The results of data fitting show that the relative error of system fitting is in the range of 0–0.75%, which is better than the approximation effect by regression analysis.

4. Experiments and Results

4.1. Dataset. In this study, first, we use the data from 1997 to 2016 to simulate the interaction between digital economy industry and new normal multiobjective using adaptive genetic algorithm optimization neural network model and compare the simulation results of the two models; second, we modulate different multiobjective conditions to analyze the sensitivity of digital economy industry development status; and finally, we make a sensitivity analysis of the development of digital economy industry in 2017–2019 digital economy industry development speed and quality are predicted and analyzed to reveal the development and integration of digital economy industry system under the new normal multiobjective conditions. In the experiments, the CPU computational speed of the server, the job requirements of the Big Data application, the software failure rate of the VM, and the hardware failure rate of the server were the first parameters evaluated: the computational speed of the server can be measured by mapping its CPU frequency to the MIPS level, and in the experiments, a multicore CPU configured with 163.0 GHz was used as the host physical node for the Big Data job. The job requirements of a Big Data job are quantified by its computational complexity as the number of instructions that need to be executed. In the experiments, the big data job used is a data processing task with an evaluated work requirement of 32T10 instructions.

4.2. Analysis of the Results of the Digital Economy and Industry Convergence Model. The sample data were divided into training sample (80%) and test sample (20%); the training sample was used to determine the parameters of the model, and the test sample was used to estimate the model and compare the errors of the 20 years of data from 1997 to 2016, 16 years of data from 1997 to 2012 were selected as the training sample, and the last 4 years (2013–2016) of data were used as the test sample. In this study, the MATLAB R2014a neural network toolbox is used to complete the neural network operation. The proposed neural network model of the digital economy industrial system under the new normal multiobjective conditions consists of an input layer, an implicit layer, and an output layer. The input layer of the network is 7 indicators of the new normal multiobjective and digital economy industrial system impact factors; the output layer is 2 indicators of the development status of the digital economy industrial system, while the implicit layer is set as one layer, and the number of implicit neurons is obtained by adaptive genetic algorithm. According to experience, in BP neural network training, the network training target is set to 0.001% and the learning rate is 0.05; in the process of optimizing the initial weights of the neural network by genetic algorithm, the number of populations is 100, the number of genetic iterations is 300, the

TABLE 1: Simulation results and error values of test samples (%).

| Classification | Year | Actual value | Proposed method | | | Contrasting approach | | |
|--|------|--------------|------------------|----------------|----------------|----------------------|----------------|----------------|
| | | | Simulation value | Absolute error | Relative error | Simulation value | Absolute error | Relative error |
| Digital economy total assets change rate | 2013 | 13.270 | 13.339 | 0.069 | 0.518 | 13.156 | -0.114 | -0.863 |
| | 2014 | 13.862 | 13.985 | 0.123 | 0.890 | 14.026 | 0.164 | 1.186 |
| | 2015 | 15.667 | 15.510 | -0.157 | -1.001 | 15.857 | 0.189 | 1.210 |
| | 2016 | 16.514 | 16.364 | -0.150 | -0.909 | 15.524 | -0.990 | -5.996 |
| Commercial bank nonperforming loan ratio | 2013 | 1.000 | 0.962 | -0.038 | -3.770 | 1.025 | 0.025 | 2.519 |
| | 2014 | 1.250 | 1.248 | -0.002 | -0.181 | 1.200 | -0.050 | -4.031 |
| | 2015 | 1.670 | 1.678 | 0.008 | 0.490 | 1.695 | 0.025 | 1.480 |
| | 2016 | 1.750 | 1.716 | -0.034 | -1.925 | 1.724 | -0.026 | -1.498 |

TABLE 2: Error analysis of simulation results of test samples (%).

| Methods | Classification | Mean square error | Mean relative error | Maximum relative error |
|----------------------|--|-------------------|---------------------|------------------------|
| Proposed method | Total assets change rate of digital economy | 0.129 | 0.830 | 1.001 |
| | Nonperforming loan ratio of commercial banks | 0.026 | 1.592 | 3.770 |
| | Total | 0.093 | 1.213 | 3.770 |
| Contrasting approach | Total assets change rate of digital economy | 0.514 | 2.314 | 5.996 |
| | Nonperforming loan ratio of commercial banks | 0.033 | 2.382 | 4.031 |
| | Total | 0.364 | 2.342 | 5.996 |

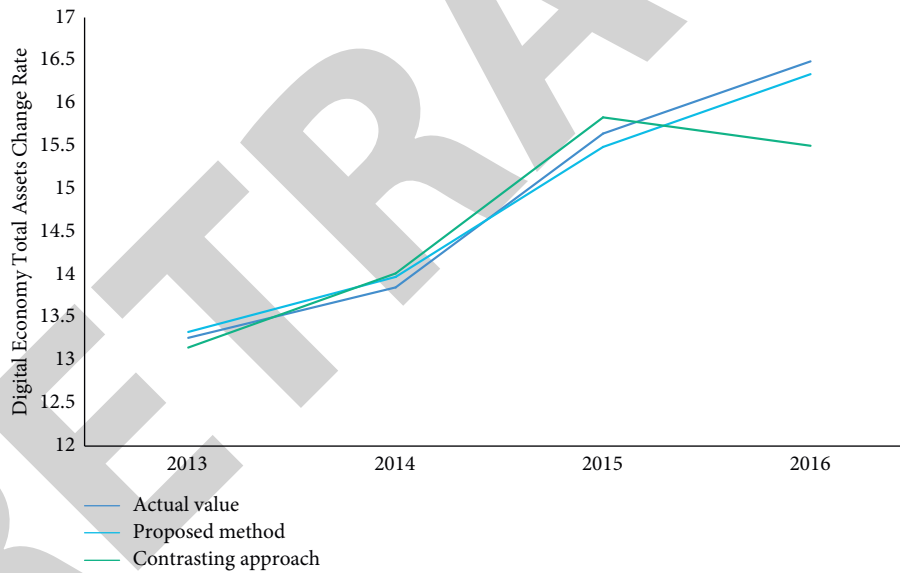


FIGURE 5: Simulated and actual values of the rate of change of total assets in the digital economy (%).

value of crossover probability is 0.7, and the probability of variation is 0.05; in the adaptive parameters, the upper and lower limits of variation probability are 0.25 and 0.05, and the crossover, the upper and lower limits of the probability are 0.8 and 0.5. The proposed neural network and the comparison method neural network are used to simulate the development and integration of the digital economy industry system, respectively, and after the training, the trained network is used to simulate and predict the test samples. The simulation results of the test samples from 2013 to 2016 are given in Tables 1 and 2 and Figures 5 and 6.

From Figures 5 and 6 and Tables 1 and 2, it can be seen that the average relative error between the simulated and actual values of the training results of the proposed neural network model for the total asset change rate and the nonperforming loan rate of the bank is 1.213% and the maximum relative error is 3.77%, while the average relative error of the training of the neural network model of the comparison method is 2.342% and the maximum relative error is 5.996%. It is known that the proposed neural network model is better than the comparison method neural network model. To further illustrate the superiority of the

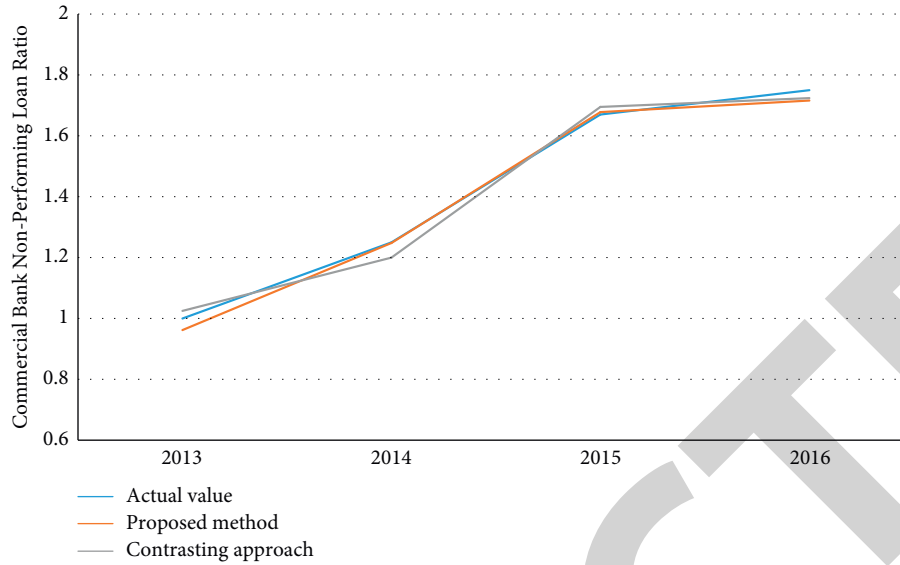


FIGURE 6: Simulated and actual values of NPL ratio of commercial banks (%).

TABLE 3: Comparison of the simulation performance of the two models.

| Method | Training time (sec) | Convergence accuracy | Number of iterations |
|----------------------|---------------------|----------------------|----------------------|
| Proposed method | 461.11 | 247 | 0.0011 |
| Contrasting approach | 910.18 | 328 | 0.0316 |

proposed neural network model, the training time, number of iterations, and convergence accuracy of the proposed neural network model and the comparison method neural network model are compared, and the simulation performance of the two models is analyzed, and the results are given in Table 3.

It can be seen that the training time, number of iterations, and convergence accuracy of the proposed neural network model are significantly better than those of the comparison method neural network model. In summary, it can be seen that the proposed neural network model has stronger simulation capability, lower error value of the test sample simulation, higher accuracy of the simulation, and shorter running time. Therefore, this study concludes that the proposed neural network model can be used as a method to predict the development and convergence of the digital economy industrial system, and this study will regulate and predict the development and convergence of the digital economy industrial system on this basis.

4.3. Scientific Computing Visual Analysis

Moderation. In order to further analyze the impact of the new normal objectives on the industrial system of digital economy, this study proposes three scenario hypotheses and sensitivity moderation of multiobjective conditional variables to study their impact on the rate of change of total bank assets and the nonperforming loan rate of commercial banks, respectively. The visualization of the training process performance improvement is shown in Figure 7. The

visualization of the loss-drop of the training process is shown in Figure 8. Economic transformation and upgrading need the support of innovation drive, and under the new normal conditions, China cannot rely only on factor scale drive and investment drive to promote the development of economic digital economy but should rely more on technological progress and let innovation become the new engine to drive development. R&D as the driving force of technological progress: increasing the proportion of R&D expenditure can mobilize the enthusiasm of innovation and increase the vitality of the economy, according to which the third scenario hypothesis is proposed; the proportion of R&D expenditure to GDP rises by 10%. Using the already trained neural network model, the indicators of 2016 are used as the initial values, based on which the sensitivity of the regulatory variables is controlled according to the multiobjective conditions, and the results are given in Table 4. *Scenario Hypothesis 1.* When the GDP growth rate decreases by 10% and other variables remain unchanged, the growth rate of total bank assets is 14.82% and the nonperforming loan rate of commercial banks is 1.64%. *Scenario Hypothesis 2.* When the contribution of the three industries rises by 10%, the growth rate of total bank assets is 14.42% and the nonperforming loan ratio of banks is 1.78%. *Scenario Hypothesis 3.* When the ratio of R&D expenditure to GDP rises by 10%, the growth rate of total bank assets is 15.97% and the nonperforming loan ratio of banks is 1.62%. When the economic growth rate decreases, the growth rate of total bank assets decreases and the nonperforming loan ratio of commercial banks decreases. When there is downward pressure on the economy, the investment and

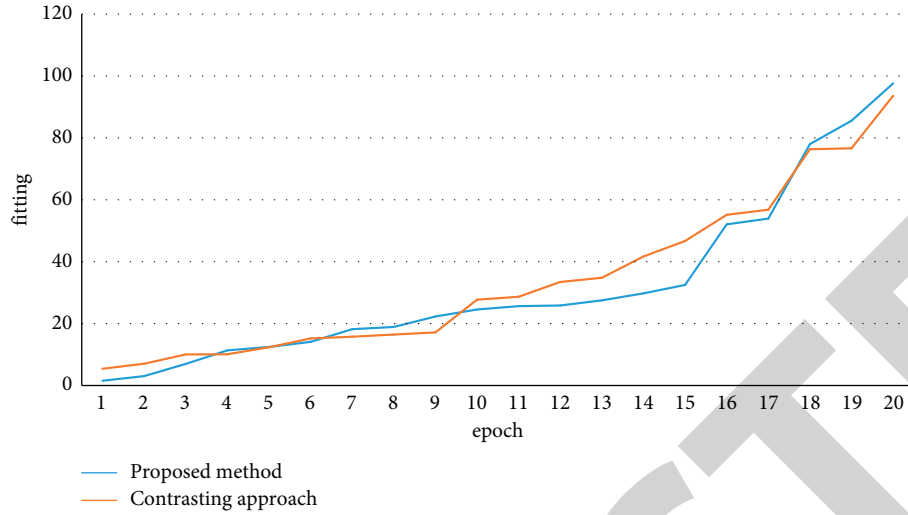


FIGURE 7: Visualization of training process performance improvement.

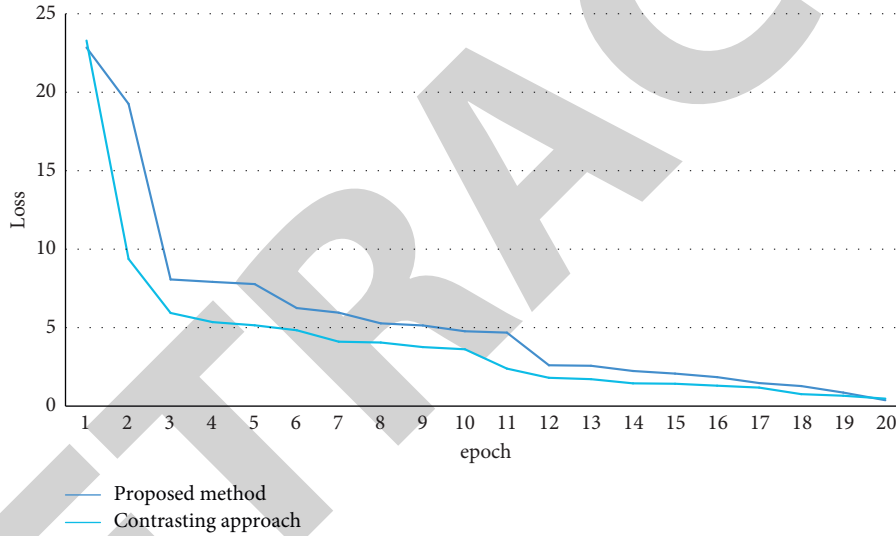


FIGURE 8: Training process loss degradation visualization.

TABLE 4: Sensitivity modulation table of the new normal target to the digital economy industry.

| Scenario assumptions | GDP growth rate | Contribution rate of three industries | R&D expenditure as a percentage of GDP | Total assets of banking industry growth rate (%) | Nonperforming commercial banks loan ratio (%) |
|----------------------|-----------------|---------------------------------------|--|--|---|
| Initial value | 9.96% | 51.91% | 2.10% | 16.51 | 1.75 |
| Scenario 1 | 10% decrease | Unchanged | Unchanged | 14.82 | 1.64 |
| Scenario 2 | No change | 10% increase | Unchanged | 14.42 | 1.78 |
| Scenario 3 | Unchanged | Unchanged | 10% increase | 15.97 | 1.62 |

financing demand of the real economy will decrease, and banks, as the main indirect financing channel, will tighten their banking and deposit and loan business in order to prevent being affected by the risks of the real economy, and the growth of credit assets decelerates, causing the growth rate of total assets of banks to decrease and the growth of earnings to slow down. However, at the same time, banks' risky assets decrease, banks' nonperforming loan ratio

decreases, and the quality of digital economy industry improves.

When the contribution rate of the three industries increases, the growth rate of total bank assets decreases and the nonperforming loan rate of commercial banks increases. The integration of digital economy industries relies on the real economy, and the secondary industry is the main component of the real economy. When the proportion of tertiary

industry increases and the proportion of secondary industry decreases, it will cause the decrease of investment and financing demand of real economy, and the increment of bank assets decreases, causing the decrease of asset growth rate. And the rise of bank NPL rate indicates that the tertiary industry is more likely to generate nonperforming assets and default risk than the secondary industry, causing the increase of bank NPL rate. When the share of R&D expenditure in GDP increases, the growth rate of total bank assets and the NPL rate of commercial banks both show a decrease. When technological R&D is the driving force, increased investment in technological innovation reduces the demand for factors such as capital, decreases the reliance on financing channels such as banks, reduces banks' credit assets and risky assets, and decreases the growth rate of bank assets, while the quality of assets increases. The sensitivity of the regulatory variables to the growth rate of total bank assets and the nonperforming loan rate of commercial banks shows an opposite trend, with a smaller impact on the nonperforming loan rate when there is a greater impact on the growth rate of total assets, indicating that the impact of a single new normal target on the speed and quality of digital economy industry integration cannot be achieved at the same time. Therefore, to achieve the unity of speed and quality of digital economy industry integration, it is necessary to combine multiple goals of the new normal and not to emphasize only one new normal goal of integration. Under the new normal, the digital economy industry has entered a stable period of growth. The digital economy industry actively adjusts the structure of the digital economy, from improving the financing structure, optimizing the investment of loans, and expanding the profit model of digital economy institutions and other aspects, to promote the reform of the digital economy industry, reduce the risk of the digital economy, and improve the quality of digital economy assets. The digital economy industry should actively adapt to the new normal, adjust the psychological expectations of the speed of business integration, and change the past mode of pursuing large-scale, high-velocity integration to one of maintaining moderate and high-quality integrations.

5. Conclusion

In the foreseeable future, the digital economy can not only help China's real economy, but also enable China to win long-term economic development momentum in the future. A strong innovation capability is certainly a sufficient condition for the sustainable development of the digital economy, and its own development also requires the regulatory role of the market mechanism. The successful experiences of Silicon Valley and Taiwan's Industrial Technology Research Institute are typical cases of attaching importance to market technology, and the enterprises that survive through market battles are bound to having comprehensive capabilities, and such enterprises are capable of doing industrial structure migration and productivity in the new round of digital economy development. The tide of scientific and technological innovation: In terms of policy, all places should thoroughly implement the central decision

and deployment, accelerate the circulation of digital economy elements and the distribution of factor resources, accelerate the development of science and technology, and promote industrial optimization and upgrading. The sudden new pneumonia epidemic has forced more enterprises to "go to the cloud," which provides opportunities for the development of the digital economy. To seize this window period, not only build a new digital ecology, create an experimental zone for the development of the digital economy, and clarify the systematic circulation, trading, and use of factors around the mechanism but also protect the security of information, planning data as a property right to establish the mechanism. In the future, we plan to carry out scientific computational visualization on convolutional neural networks and knowledge graphs for industrial convergence in the context of the digital economy.

Data Availability

The datasets used during the current study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

The study was supported by Henan Provincial Soft Science Program, Henan (212400410107), Henan Philosophy and Social Science Planning project Henan Province, Henan (2020BJJ015), and Key Scientific Research Projects of Colleges and Universities in Henan Province, Henan (21A790003).

References

- [1] B. Ji, Y. Li, D. Cao, C. Li, S. Mumtaz, and D. Wang, "Secrecy performance analysis of UAV assisted relay transmission for cognitive network with energy harvesting," *IEEE Transactions on Vehicular Technology*, vol. 69, no. 7, pp. 7404–7415, 2020.
- [2] X. Lin, J. Wu, S. Mumtaz, S. Garg, J. Li, and M. Guizani, "Blockchain-based on-demand computing resource trading in IoV-assisted smart city," *IEEE Transactions on Emerging Topics in Computing*, vol. 9, no. 3, pp. 1373–1385, 2021.
- [3] J. Li, Z. Zhou, J. Wu et al., "Decentralized on-demand energy supply for blockchain in Internet of Things: a microgrids approach," *IEEE Transactions on Computational Social Systems*, vol. 6, no. 6, pp. 1395–1406, 2019.
- [4] L.-N. Kwon, J.-H. Park, Y.-H. Moon, B. Lee, Y. Shin, and Y.-K. Kim, "Weak signal detecting of industry convergence using information of products and services of global listed companies - focusing on growth engine industry in South Korea -," *Journal of Open Innovation: Technology, Market, and Complexity*, vol. 4, no. 1, p. 10, 2018.
- [5] Y. Zhou, F. Dong, D. Kong, and Y. Liu, "Unfolding the convergence process of scientific knowledge for the early identification of emerging technologies," *Technological Forecasting and Social Change*, vol. 144, pp. 205–220, 2019.
- [6] P. Radanliev, D. De Roure, J. R. C. Nurse, R. Nicolescu, M. Huth, and S. Cannady, "New developments in cyber physical systems, the Internet of Things and the digital

Retraction

Retracted: The Protection and Restoration of Ancient Buildings in Guanzhong Traditional Villages Based on the Improved Priority Algorithm

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] C. Li and Y. Zhao, "The Protection and Restoration of Ancient Buildings in Guanzhong Traditional Villages Based on the Improved Priority Algorithm," *Mobile Information Systems*, vol. 2022, Article ID 8203590, 8 pages, 2022.

Research Article

The Protection and Restoration of Ancient Buildings in Guanzhong Traditional Villages Based on the Improved Priority Algorithm

Chang Li  and Yiyuan Zhao

Xi'an University of Architecture and Technology Huaqing College, Xi'an, Shaanxi Province 710043, China

Correspondence should be addressed to Chang Li; 2016122540@jou.edu.cn

Received 26 April 2022; Revised 27 May 2022; Accepted 1 June 2022; Published 27 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Chang Li and Yiyuan Zhao. 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.

Architecture is closely related to human development. Different architectural shapes and texture structures reflect the changes of society and the level of social development. They are not only important materials for studying history but also carry the profound significance of human history. However, due to chemical effects, the acid, alkali, salt, and corrosive solvents are applied and produced in the process of industrial production, as well as the corrosive media contained in the atmosphere, groundwater, surface water, and soil will corrode the ancient buildings. The whole picture of many ancient buildings cannot be completely preserved, let alone used as research materials to deeply explore history and humanities. With the development of computer science and technology, we hope to protect and repair traditional ancient buildings through modern technology, which not only respects the long history of the Chinese nation but also helps us better study history through ancient buildings. This paper takes the ancient buildings of traditional villages in Guanzhong, Shanxi Province as an example, optimizes them on the basis of predecessors, and explores the protection and restoration of ancient buildings based on the improved priority algorithm. The results show that the proposed algorithm performs better in the protection and restoration model of ancient buildings than the traditional algorithm.

1. Introduction

China is a country with a long history. In the long history of more than 5000 years, the ancients left us countless Chinese civilization. These civilizations are handed down through cultural relics, showing us the social development at that time, which is the historical proof of the continuous struggle of our Chinese nation for 5000 years, and we also continue to absorb and carry forward the excellent traditional culture of the Chinese nation from cultural relics [1]. Objectively speaking, cultural relics are the material inheritance of the Chinese national spirit; subjectively, cultural relics are also the link of the excellent national spirit of the Chinese nation. Therefore, the protection of cultural relics not only helps us learn relevant experience from history but also plays an important role in enhancing China's cultural self-confidence

and national cohesion through the protection and restoration of cultural relics to meet the increasing spiritual needs of the people today when people's material life is gradually met [2]. In the 12th five-year plan, China proposed to strengthen modern information technology, build and improve the basic database of national cultural relics resources through information technology, establish an information platform for the preventive protection of cultural relics, and promote the digital museum project [3]. In China's 13th five-year plan, it continues to propose to build national projects. Through the implementation of the national digital preservation action plan, the cultural relics representative of China's excellent traditional culture, revolutionary culture, and advanced socialist culture will be preserved in batches [4]. With the advent of the follow-up Internet era, we hope to combine the Internet plus model with the protection of

cultural relics. Through the active guidance of the government and the active participation of the whole society, jointly promote the protection and restoration of cultural relics reflecting the traditional culture of the Chinese nation and integrate innovative ideas with practical development in combination with the Internet and technology. In the protection and restoration plan of cultural relics, there is a special kind of cultural relics: ancient architectural relics. Ancient architectural relics are different from some small cultural relics such as books, handicrafts, and costumes. These cultural relics are small in volume and common in material and have a large number of reference materials. They are also relatively simple to operate and less difficult to repair. However, the ancient architectural relics are large in size and have experienced natural corrosion factors such as weathering, earthquake, and oxidation for thousands of years. In addition, due to the restrictions of materials under the construction environment at that time, some buildings only use the mixed materials of soil and stone, which have low corrosion resistance and poor ductility. So far, there are few buildings that can be preserved, which makes us have less reference materials in the repair process, it cannot be restored accurately during the restoration process (Shi R et al. 2020) [5]. At the same time, the building volume is relatively large. In the process of repair, it often affects the whole body for a structure, making it more difficult to repair. Taking the traditional ancient buildings in the Guanzhong area of Shanxi province as an example, as the territory of the ancient Qin state, Guanzhong, Shanxi province has been the national capital for 13 times in history. Therefore, it has a stronger history in political, economic, and cultural development than other areas. At present, it is an area with more ancient buildings preserved all over the country. Influenced by the development of the times, in the change of traditional dynasties in history, the main buildings changed in urban areas, while the ancient buildings in ancient traditional village areas have been well preserved so far. Through the ancient buildings of these traditional villages, we can have a deeper understanding of the social background, cultural outlook, and social productivity at that time. However, due to historical changes, we cannot study the whole picture of ancient buildings in traditional villages in Guanzhong. Today, the appearance is more or less damaged, which is also the biggest obstacle we encounter when studying cultural relics. Therefore, here we take the Guanzhong area as an example to explore the protection and restoration of ancient buildings in traditional villages in Guanzhong based on the improved priority algorithm [6].

2. Related Work

The protection and restoration of ancient buildings in traditional villages in Guanzhong mainly goes through two stages. The first stage is to convert the three-dimensional image of existing ancient buildings into two-dimensional form through surveying and mapping technology. This stage is to accurately collect the data of ancient buildings so as to better formulate protection and restoration strategies in the future. The surveying and mapping technology for

ancient buildings in traditional villages in Guanzhong has been developed for a long time. The early surveying and mapping technology mainly adopts manual surveying and mapping. At this time, the surveying and mapping instruments are only simple tools such as flat panel instrument, rangefinder, theodolite, and calculator [7]. In the process of ranging, the specific fixed-point distance is more by naked eye and manual means, such as shoulder lifting by one person or lifting by multiple people, or dragging by cattle and sheep. The mapped final products are also mostly displayed in the form of physical objects, such as paper maps or globes [8]. The advantages of manual surveying and mapping are low technical content and simple requirements for scientific and technological tools. However, the surveying and mapping method is very vulnerable to the influence of weather and natural environment. Most of the early surveying and mapping technology is carried out in the field, and the cost is high. Especially when the weather is bad, it greatly increases the cost of field work. At the same time, the geographical environment where the ancient buildings are located also has a significant impact on the surveying and mapping. Compared with the ancient buildings located in the plain, for the ancient buildings located in the harsh geographical environment such as mountain pelvis or depression, the manual hand drawing method has large error and inaccurate results [9]. In the 1990s, with the application of China's surveying and mapping industry to all walks of life, the surveying and mapping industry officially entered the digital stage. The main feature of this stage and the traditional surveying and mapping stage is the change of measuring instruments. Digital surveying and mapping technology uses more high-tech measuring instruments for direct measurement and automatically records the land occupation of the measured ancient buildings as points, establishes a plane rectangular coordinate system, and automatically generates the measured information in the plane rectangular coordinate system. At this time, most of the surveying and mapping work is completed by the instrument, and the manual only needs to mark or explain the figure automatically drawn by the measuring instrument [10]. This stage greatly reduces the time spent by manpower in the process of surveying and mapping, reduces the manpower difficulty of surveying and mapping, and significantly improves the efficiency of surveying and mapping. At the same time, the products at this stage are no longer materialized but generate corresponding digital products according to the specific needs of users. Users can independently select the required data for assembly or recording according to their own needs, which has strong flexibility [11]. Compared with the physical surveying and mapping products produced by traditional surveying and mapping technology, they need to be reprinted and published when they are updated. The digital products can be modified in real time on the Internet, which can realize dynamic maintenance. Digital products are easier to maintain and faster to upgrade. In modern society, surveying and mapping technology relies more on information-based operation means combined with modern information technologies, such as remote sensing

technology, geographic information system, and global positioning system to collect, process, and analyze the spatial information of ancient buildings, collectively referred to as “3S” technology. The testing methods and means of information-based surveying and mapping technology have completely changed qualitatively. One of the important signs is that the whole process of surveying and mapping under this technology needs the participation and support of computers. At the same time, space instruments such as satellites and aircraft are widely used as measurement systems in the application of measurement instruments. Moreover, in information-based surveying and mapping technology, more time is applied to the link of data analysis and processing, and the process of data acquisition and mapping with the help of modern information measurement tools takes less time [13]. This also promotes the development of the second stage of the research on the protection and restoration of ancient buildings in traditional villages in Guanzhong; that is, the restoration of the images of ancient buildings in traditional villages in Guanzhong drawn by surveying and mapping technology. This is because ancient buildings have been scoured for thousands of years and subjected to various natural oxidation and corrosion. What we see now is often not the original appearance of ancient buildings when they were built [14]. Unlike works of art, costumes, and other cultural relics, ancient buildings can be recorded through books. Therefore, there are few relevant materials for repairing the whole picture of ancient buildings. With the great involvement of computer technology in the information age, more and more computer algorithms are used in the protection and restoration of ancient buildings. For example, foreign scholars Beralmio et al. first introduced the partial differential equation into the research on the protection and restoration of ancient buildings in 2000, and then Chinese scholars Chan et al. proposed the TV model on this basis, making corresponding contributions to the protection and restoration of ancient buildings [15, 16].

3. Method

This paper mainly focuses on the computer algorithm model of traditional village ancient buildings in Guanzhong in the surveying and mapping stage and restoration stage. When collecting surveying and mapping data for traditional ancient village buildings in Guanzhong, the collected data are often affected by surveying and mapping instruments; surveying and mapping angles; and surveying and mapping object materials and surface smoothness. The collected data often have small noise or outliers. Taking this as the data source, the restored images of traditional village ancient buildings in Guanzhong are often highly distorted, and the later restoration stage of ancient buildings in Guanzhong is often repaired through surveying and mapping data. This greatly affected the restoration of ancient buildings in Guanzhong in the later stage. In the stage of protection and restoration of traditional ancient buildings in Guanzhong, researchers have used computer algorithms to improve the efficiency and accuracy of surveying and mapping, but the

resolution of traditional algorithms is still low when optimizing the accuracy of surveying and mapping, and in some cases, in order to maximize the accuracy of surveying and mapping, more detailed data of ancient buildings are deleted. The ancients often used some details to show the local customs and traditional customs of the current society. Excessive deletion of details has brought great difficulties to the protection and restoration of ancient buildings in traditional villages in Guanzhong. At the same time, in the subsequent restoration of the ancient buildings of traditional villages in Guanzhong, the edge of the image synthesized by the traditional algorithm is rough, which cannot actually restore the original appearance of the ancient buildings of traditional villages in Guanzhong. In particular, the texture of traditional ancient buildings in the Guanzhong area has rich changes, and the edges are mostly irregular lines, which are affected by nature. Most of the models reconstructed according to the surveying and mapping data have defects. Whether the defective elements can be perfectly filled is the focus of the restoration of traditional ancient buildings in Guanzhong villages. Therefore, this paper improves the main algorithm of traditional village ancient buildings in Guanzhong in the mapping and restoration stage to reduce noise and improve accuracy. The specific research process is shown in Figure 1.

Next, we mainly improve the surveying and mapping method according to the priority improvement algorithm. The traditional surveying and mapping algorithm is mainly the automatic registration algorithm of cloud data. This algorithm is mainly based on the automatic registration process of noise data during reconstruction after scanning the shape of ancient buildings in traditional villages in Guanzhong through 3S system and storing them in the server system. Generally, the noise is caused by the data noise deviation caused by the deviation of the spatial positioning instrument in the acquisition process. The traditional algorithm automatically matches the cloud data. By default, one of the two matched data are noise data, and one is removed randomly, so as to achieve the function of noise cleaning. The specific algorithm is shown in formulas (1) to (3):

$$\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}, \quad (1)$$

$$\delta = L(p_i) = p_i - \frac{1}{d_i}, \quad (2)$$

$$\frac{\partial p_i}{\partial \tau} = \lambda L(p_i). \quad (3)$$

However, in the actual surveying and mapping process, the algorithm is easy to over clean the data, resulting in the final data source. Although there is less interference data, many detailed data are actually lost, which bring great difficulties to the subsequent restoration of ancient buildings in traditional villages in Guanzhong area. The noise fluctuation of surveying and mapping data with traditional methods is shown in Figure 2.

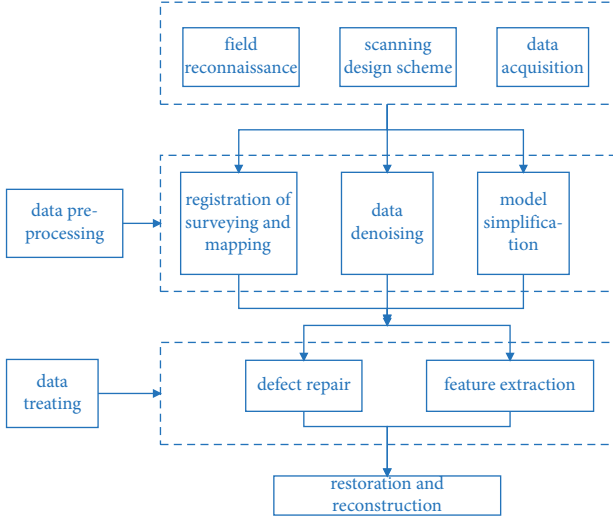


FIGURE 1: Research flow chart based on priority improvement algorithm.

From Figure 2, we can see that in the process of data acquisition, the noise fluctuates very frequently within 30 seconds, and the span is large. If it is removed only through the automatic matching algorithm, it is easy to clean the surrounding normal data points, resulting in the inaccuracy of the data source. Therefore, here we adopt the priority improvement algorithm and propose the bilateral filtering method based on the common noise smoothing algorithm. The algorithm is mainly based on the priority improvement algorithm, which diffuses the easily captured noise from local to overall according to the energy contained, and determines its priority through setting different weight values according to the actual situation through the gray value of its area. Among them, we assume that the overall dataset is C , and the full factor definition is shown in formulas (4) and (5):

$$C = \{ \{ p_i \in R^3 \} \mid i = 1, 2, \dots, n \}, \quad (4)$$

$$\hat{p}_i = p_i + \lambda n_i. \quad (5)$$

Formulas (4) and (5) define the noise cleaning weight in the data collection of ancient buildings in traditional villages in Guanzhong. Therefore, we iteratively calculate the noise sites according to the defined weight factor, and then we can get the new data point coordinates obtained by the priority improved algorithm. See the following formula for specific iterative expression:

$$\lambda = \frac{\sum_{p_j \in N(p_i)} W_c(\|p_j - p_i\|)}{\sum_{p_j \in N(p_i)} W_s(|\langle n_j, n_i \rangle - 1|)}. \quad (6)$$

The basic idea of the improved algorithm is to divide the noise into two types—large-scale noise and small-scale noise—according to the distance between the noise locus and the surveying and mapping subject. The large-scale noise is far away from the surveying and mapping subject,

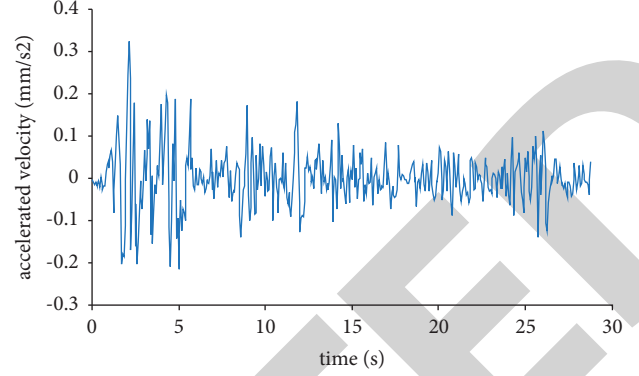


FIGURE 2: Traditional algorithms for mapping data noise fluctuations.

and we default that it is unlikely to be the real data of the subject. Therefore, we adopt the strategy of full deletion of large-scale noise. The small-scale noise is close to the main body, so we think it is more likely to be a part of the main body of surveying and mapping. Therefore, the two-way filtering algorithm is adopted for this part of noise smoothing. The expression of noise locus distance is shown in formula (7), and the bidirectional filtering algorithm for small-scale noise is shown in formula (9).

$$d_{ik}^2 = \|x_k - v_i\|^2 = \sum_{j=0}^s (x_{ki} - v_{ij})^2, \quad (7)$$

$$W_{oc}(x) = e^{-x^2/2\sigma_c^2}. \quad (8)$$

According to the improved priority based improved algorithm, we can obtain the noise change of surveying and mapping data for ancient buildings in traditional villages in Guanzhong, as shown in Figure 3.

It can be seen from Figure 3 that after the improvement of the priority algorithm, the noise value in the surveying and mapping of ancient buildings in traditional villages in Guanzhong decreases compared with that before the improvement of the algorithm. In order to ensure the universal applicability of the algorithm, we tested different ancient buildings in Guanzhong traditional villages. The results show that there is little difference in the variation of surveying and mapping noise of different ancient buildings. The style of ancient architecture in Guanzhong area is influenced by the geographical similarity of architectural style. The influence noise value in Figure 3 algorithm can reflect the noise level of ancient building surveying and mapping in this area and has universal applicability.

After determining the algorithm required for surveying and mapping, we begin the second stage of the protection and restoration of the audience's traditional village ancient buildings—the model restoration stage. The ancient buildings will be damaged more or less after experiencing the natural action. If they are not repaired, the overall structure of the ancient buildings will be damaged, which is likely to lead to the accelerated deterioration of the buildings. Therefore, in order to protect the ancient buildings of

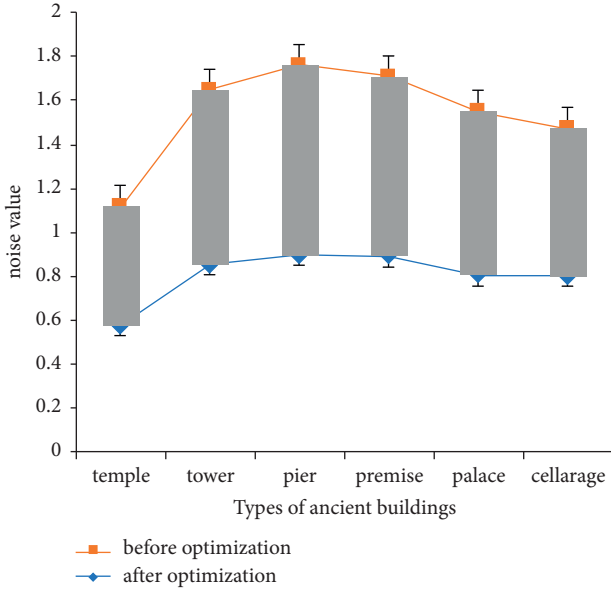


FIGURE 3: Changes of mapping noise values of different ancient buildings before and after algorithm optimization.

traditional villages in Guanzhong from collapse, we need to repair them without changing the large structure. In order to restore the original appearance of ancient buildings to the greatest extent and avoid secondary damage to ancient buildings, we first need to restore the data reconstructed by surveying and mapping. There are many traditional repair methods, such as the statistical feature algorithm of element brightness, which fills the brightness of image pigment points as the basis for repair. The specific expression is shown in the following formula:

$$\mu_n(x) = \sum_{i=0}^k (x_i - m)^2 p(x_i). \quad (9)$$

At the same time, partial differential equation can be used as the second measurement method. Both of them are typical graphic repair algorithms. The expression of partial differential equation is shown in the following formula:

$$e = \frac{1}{MN} \sqrt{\sum_{i=1}^M \sum_{j=1}^N (f(i, j) - f'(i, j))^2}. \quad (10)$$

Among them, we found that the color block filling order of the repaired area greatly affects the final filling effect. Therefore, the filling order of color blocks is the key in the priority improvement algorithm. It is particularly important in the ancient buildings of traditional villages in Guanzhong. Due to the different intensity of natural effects such as weathering and rain corrosion, the time of exposure to the air is also different. Therefore, different hues are produced. When the repair order is different, it will lead to different repair priorities. The specific color block filling sequence and the hue change after repair are shown in Figure 4.

It can be seen from Figure 4 that the final results filled with different color block filling sequences are different and

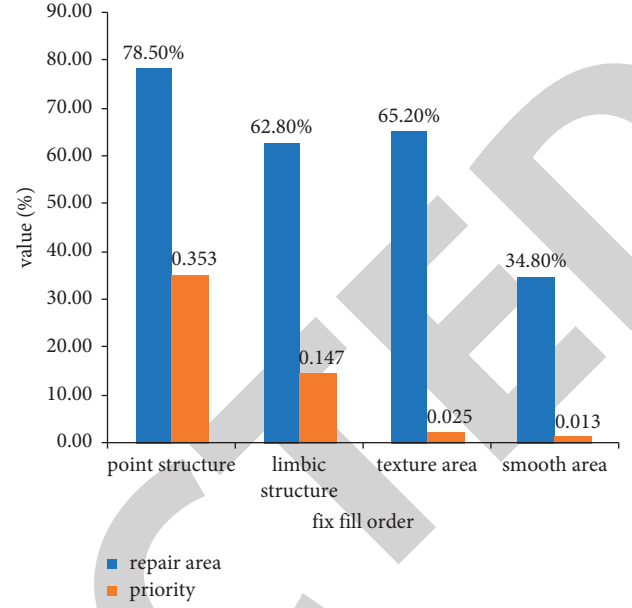


FIGURE 4: Fill effect and priority value of different repair fill order.

differ greatly. Among them, the filling area obtained by filling the overall defect through the color block sequence of corner structure is the largest, accounting for 78.5% of the total area, while the repair area obtained according to the color block filling sequence of smooth area is only 34.8%. At the same time, we can also find that the priority weights corresponding to different filling sequences are different. The better the repair effect of filling sequence is, the greater the priority weight is, and vice versa. Therefore, on the whole, the color block filling order is directly proportional to the priority weight. Next, we need to explore how to determine the optimal priority to make the repair effect the best.

Here we introduce a TV model, which introduces the P operator into the priority improvement algorithm. The minimization cost function of TV model is shown in the following formula:

$$J_\lambda[u] = \int_{E \cup D} |\nabla u| dx dy + \frac{\lambda}{2} \int_E |u - u^0|^2 dx dy. \quad (11)$$

Bring formula (11) into Lagrange multiplier to obtain Euler Lagrange equation. See formulas (12) and (13) for details.

$$-\text{div}\left(\frac{\nabla u}{|\nabla u|}\right) + \lambda_e(u - u^0) = 0, \quad (12)$$

$$\Delta u = \text{div}(|\nabla u|^{-1} \nabla u). \quad (13)$$

At this time, we establish a general digital image restoration model. In this model, we minimize all Gaussian white noise pollution through variational equations in a closed interval and then iterate continuously, so as to obtain the repair results of the damaged parts in the reconstruction model based on surveying and mapping data. The minimum

regularization equation and the expression of the iterative process are shown in formulas (14) and (15):

$$R[u] = \int_{E \cup D} r |\nabla u| dx dy, \quad (14)$$

$$\frac{\partial u}{\partial t} = \nabla \cdot \left(\frac{\nabla u}{|\nabla u|} \right) + \lambda_e (u^0 - u). \quad (15)$$

4. Result Analysis and Discussion

According to the above algorithm, we evaluate the restoration effect of ancient buildings in traditional villages in Guanzhong by improving the algorithm based on priority. The specific results are shown in Figure 5. From Figure 5, we can see that the final repair effect based on different algorithms is also different, and the repair effect is good or bad. Here, we mainly measure the area of repairing and restoring the defective part. Generally, we think that if the algorithm can repair the missing area more perfectly, the better the repair ability and effect of the algorithm. It can be seen that the TV model proposed in this paper based on the improved priority algorithm has the largest overall repair area and the best repair effect. At the same time, as the number of iterations of the algorithm increases, the repair area of the model for ancient buildings also increases. We believe that this is because the algorithm iteration increases the accuracy of the algorithm for parameters, making the repair area larger and larger.

Next, based on the priority improved algorithm model proposed in this paper, we take the ancient tower, the most common ancient building in Guanzhong traditional village, as an example to protect and repair. Ancient pagoda is one of the most common architectural structures in Chinese ancient buildings. In ancient times, it was mainly used for military monitoring or civil water intake. Affected by the geographical environment, the Guanzhong area is one of the areas with the largest number of ancient pagoda sites in China. However, for thousands of years, the appearance of ancient pagodas has been mostly damaged and weathered. Due to the special shape of ancient pagodas compared with ordinary buildings, the traditional methods have not been protected and repaired in time. In this paper, the ancient pagoda buildings in Guanzhong traditional villages are scanned and repaired through the priority improved algorithm model. The specific results are shown in Figure 6. The height of the ancient tower is more than 30m and the structure is complex. The priority improved algorithm model realizes the accurate repair of the tower.

Above, we prove that the algorithm proposed in this paper has good protection and repair for the ancient buildings of traditional villages in Guanzhong area. Compared with the traditional algorithm, this algorithm can repair the damaged part to the greatest extent. Next, in order to further prove the applicability of the algorithm in this paper, we verify the accuracy of the algorithm. The specific results are shown in Figure 7.

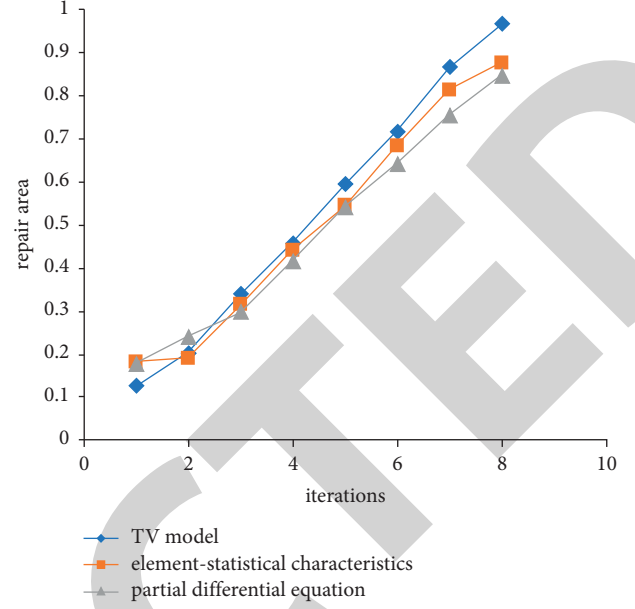


FIGURE 5: Image restoration effects of ancient buildings based on different algorithms.

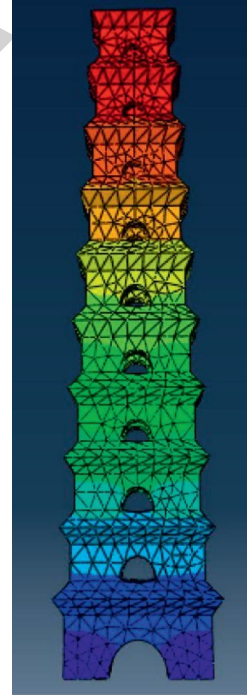


FIGURE 6: Scanning and restoration of ancient pagoda based on improved algorithm.

In Figure 7, the left ordinate represents the height and width of the ancient pagoda, the right ordinate represents the repair accuracy, and the abscissa represents different types of ancient pagodas. In order to ensure the accuracy of measurement, we randomly selected five ancient pagodas with different heights and widths to verify the accuracy of algorithm repair for ancient pagodas with different heights and widths. The results show that the restoration accuracy of

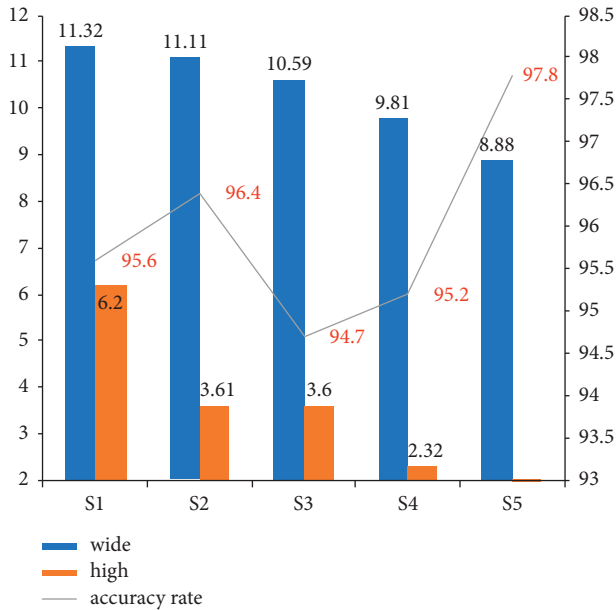


FIGURE 7: The accuracy of restoration of ancient towers under different appearances.

the five ancient pagodas is about 95% and the highest value can reach 97.8%. This further shows that the improved algorithm based on priority proposed in this paper has wide applicability. It can not only repair the integrity of ancient buildings with damaged external surface but also ensure the accuracy of repair.

5. Conclusions

- (1) Through the relevant research on the protection and restoration of traditional villages and towns in Guanzhong, the priority improvement algorithm is applied to the protection and restoration of traditional villages and towns in Guanzhong. By setting the weight of different parameters, different protection and restoration strategies can be obtained, and the restoration effect of different ancient buildings is better than the traditional mapping algorithm.
- (2) The improved priority algorithm can effectively reduce the noise value. Taking ancient pagodas as an example, for ancient pagodas with different heights and widths, the average restoration accuracy is 95%, the maximum accuracy is 97.8%, and the restoration accuracy is high, indicating that the improved algorithm based on priority has wide applicability.
- (3) Based on the improved priority algorithm, this paper recalculates the priority of parameters, combined with the two different stages of ancient building protection and restoration, which significantly improves the accuracy during the surveying and mapping of ancient buildings in traditional villages in Guanzhong, improves the image restoration effect

of ancient buildings in traditional villages in Guanzhong, and provides a new method for the protection and restoration of ancient buildings in traditional villages in Guanzhong.

Data Availability

The figures used to support the findings of this study are included in the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

- [1] H. F. Fan, "An image restoration algorithm based on improved priority calculation coupled tone similarity [J]," *Journal of luoyang institute of science and technology (natural science edition)*, vol. 3, pp. 64–68, 2020.
- [2] D. U. Zhang, "Image restoration algorithm based on improved priority calculation coupled tone similarity [J]," *System simulation technology*, vol. 2, pp. 73–77, 2020.
- [3] C. Qi, W. Tang, T. Wan, Y. Zhu, and T. Wu, "Design and implementation of Criminisi Algorithm with Improved priority in image restoration [J]," *TV technology lancet*, vol. 2, pp. 105–110, 2019.
- [4] L. Liang, Y. Ling, and L. Zhang, "Application of bim technology in ancient building restoration: a case study of wanzai ancestral temple group restoration project [J]," *China Building Decoration & Decoration*, vol. 11, pp. 42–43, 2021.
- [5] R. Shi, "Research on the Application of BIM Technology, 3D scanning technology and GIS Technology in the restoration and protection of ancient buildings," *Journal of Software*, vol. 9, pp. 123–126, 2020.
- [6] X. Wu and W. Chen, "Application of 3D laser scanning technology in ancient architecture restoration [J]," *Residence*, vol. 26, pp. 70–147, 2018.
- [7] S. Qi and R. Xu, "Application of color transfer algorithm in virtual color restoration of ancient buildings [J]," *Information Technology and Standardization*, vol. 4, pp. 67–69, 2012.
- [8] Da. Qi and S. Yin, "Research on decorative patterns of ancient buildings in Guanzhong area -- A case study of Tang Family Courtyard [J]," *Think Tank Times*, vol. 21, pp. 121–122, 2019.
- [9] Y. Hou, J. Peng, and D. Han, "Research on improved Criminisi image repair algorithm," [J]. *Computer engineering and applications*, vol. 51, no. 11, pp. 135–144, 2015.
- [10] L. Wang and X. Xiao, "Research on criminisi image restoration algorithm based on improved priority [J]," *Journal of jinggangshan university (natural science edition)*, vol. 6, pp. 44–48, 2018.
- [11] R. Kong, "Research on digital technology in ancient building protection [J]," *Cultural Industry*, vol. 36, pp. 55–57, 2021.
- [12] R. U. I. Kong, "Analysis on digital protection of ancient buildings in the Era of information technology [J]," *Cultural Industry*, vol. 35, pp. 16–18, 2021.
- [13] H. Guo, Y. Zhou, H. Chen, H. Yu, X. Yu Jin, and L. Sang, "Research on the digital protection of ancient buildings by introducing BIM technology -- A case study of Fengyang Ming Drum Tower and Ming Emperor mausoleum [J]," *Anhui building*, vol. 10, pp. 150–152, 2021.

Retraction

Retracted: Online Simulation Quality Assessment of Illustration Patterns Based on Digital Art Design in Neural Network Perspective

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Yang, "Online Simulation Quality Assessment of Illustration Patterns Based on Digital Art Design in Neural Network Perspective," *Mobile Information Systems*, vol. 2022, Article ID 7152454, 9 pages, 2022.

Research Article

Online Simulation Quality Assessment of Illustration Patterns Based on Digital Art Design in Neural Network Perspective

Lin Yang 

Shangluo University, Shangluo, Shaanxi 726000, China

Correspondence should be addressed to Lin Yang; 228020@slxy.edu.cn

Received 11 May 2022; Revised 1 June 2022; Accepted 7 June 2022; Published 27 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Lin 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.

Digital art illustration as new media is a major advancement in the history of illustration. It has broadened the application of graphic arts and the way of communication. At present, digital illustrators are constantly exploring new artistic expressions for digital illustration in order to pursue new digital effects. A wide range of integrated materials and experimental design concepts are gradually emerging, making digital illustration evolve in the competition. The artistic style of digital illustration has also shown the development trend of “diversification.” With the trend of commercialization of digital illustration, the quality of illustration patterns is gradually neglected. The traditional illustration pattern assessment relies on manual subjective judgment, with backward evaluation means and poor accuracy. This study proposes an illustration pattern evaluation method based on a deep neural network. In particular, this study proposes a reference-free image evaluation model with multiple feature fusion; specifically, we use CNN and information entropy-based methods for feature extraction and regularization methods for information fusion to solve the problem of missing reference images in applications. The chunking process is performed on the basis of considering the influence of information entropy on image quality, and the information entropy of multiple chunked features is calculated as importance weights, representing the degree of their influence on distorted image quality. The experimental results on the digital illustration pattern database show that the method in this study has strong robustness and can output a reasonable and reliable quality assessment score for distorted patterns.

1. Introduction

The art of digital illustration has matured with the development of digital technology. Digital technology has developed at an amazing rate in just a few decades. Driven by digital technology, illustration art has derived new visual effects and greatly enriched the language of illustration art. Digital visual communication stands rightfully in front of the public as one of the most applicable means to realize human life. It has profoundly changed the way people access information. At the same time, powerful computer software systems have revolutionized the illustrator’s own industrial revolution. Efficient digital illustration art has also become a key part of the “age of reading picture” [1]. In addition, the digital age has a broader impact on human work, thought, and so on. Illustration art is an important way of visual language, which has the advantages of being intuitive, realistic, and infectious. It is loved by the general public. The

impact of digitalization on the art of illustration is multifaceted; for example, it changes the means of creating illustration, makes the art of illustration more diverse, and makes the art of illustration more attractive to the audience. In such a social context, digital illustration has a large “consumer base.” This potential commercial value was exploited, resulting in the art of illustration having a strong market value, while making it active, popular, and greatly stimulating its development. Digital technology has started to fully intervene in various industries of commercial art, such as graphic design, commercial illustration, exhibition display, advertising and packaging, industrial styling design, environmental art design, and architectural design [2].

Compared with traditional illustration, digital illustration is more diversified and richer in terms of form and content. Specifically, first, according to the performance language and style criteria, it can be divided into conceptual digital illustration, hybrid digital illustration, vector digital

illustration, and abstract digital illustration. Second, according to the performance content standard, it can be divided into digital illustration of people, digital illustration of animals, digital illustration of landscape, and so on. Third, according to the market perspective, it can be divided into commercial digital illustration and noncommercial digital illustration. Although with the aid of computer software, illustration has become easier to draw. However, to create excellent digital illustration works, it is also necessary to follow certain drawing methods and strict image quality assessment criteria. The merits of the drawing affect the overall aesthetic and artistic standards of digital illustration to a large extent. Good drawing standards will make the creation of the entire illustration appear harmonious and smooth and create a sense of beauty to the audience after completion. Inappropriate composition will reduce the beauty of the entire work and lower its artistic standards. However, with the increasing proportion of commercialization, many hand-drawn designers choose to learn software to adapt to this fast-paced society, so “fast food design” has emerged. People seem to be more inclined to the pursuit of technology but ignore the pursuit of pattern art and quality.

Image quality assessment has been a fundamental problem in the field of image processing and computer vision. Image quality assessment models are also widely used in the fields of image coding, super-resolution reconstruction, image quality enhancement, and other related fields [3]. Image quality assessment mainly includes full-reference image quality assessment, half-reference image quality assessment, and no-reference image quality assessment [4]. Full-reference image quality assessment and half-reference image quality assessment refer to the full availability and partial availability of reference information for predicting image quality, respectively, while no-reference image quality assessment refers to the unavailability of reference information for predicting image quality. Although full-reference and half-reference image quality assessment models are more reliable, they must rely on reference information in the calculation process, which makes the application extremely limited. The reference-free image quality assessment model has been a hot topic of research in the field of image quality assessment because it is not dependent on reference information and has strong applicability.

Digital illustrations, as images generated by information technology, are easy to obtain a large amount of raw image data. However, annotating images is time consuming and laborious, so it is difficult to collect reference images for training models. The main contributions of this study are as follows: (1) in this study, we propose a quality assessment method for reference-free illustration patterns based on multifeature fusion. For an illustration pattern, this study first chunks it into multiple blocks. (2) Then, the information entropy of each block is calculated as the importance weight of the block, which represents its impact on the quality of the distorted image. The loss function of the convolutional neural network is adjusted according to this weight. (3) The experimental results show that the reference-free image quality assessment method proposed in this study can accurately assess the quality of digital illustration patterns, and

the assessment results are close to the subjective visual assessment of humans.

2. Related Works

2.1. Research Status of Illustration Pattern Based on Digital Art Design. Digital illustration art has the characteristics of digital creativity and digital media display and interaction. Digital illustration art is a product of the digital age and is a branch of digital art. Digital illustration art is a visual art that is created and designed to achieve certain purposes through “digital” technology. This is a broad definition of digital illustration art. As long as there is a digital component involved in the creation and final display process of illustration, it can be summarized as digital illustration art, for example, preinformation collection, postsynthesis, diversity of creators, and multimedia presentation. Digital illustration art is a comprehensive digital creation art form. It has the distinctive features of fusion of digital technology and art as well as artistic characteristics and aesthetic features of the digital era. It breaks with the traditional means of creation and communication medium of illustration and has a unique aesthetic characteristic of “multiple synthesis” [5].

In the information age, different fields have encountered new opportunities for development, and this is also true for the field of illustration. With the help of powerful information technology and tools, digital illustration art can exhibit many characteristics, especially in terms of performance language and display space [6]. Digital illustration art is very different from traditional illustration art. However, in essence, digital illustration art in the information age is also developed on the basis of traditional flower arrangement art. Therefore, although they have different qualities, digital illustration art adheres to many characteristics of traditional illustration art. For example, traditional illustration art focuses on innovation and inspiration. This has not changed in the digital illustration art of the information age. In addition, traditional illustration art attaches importance to the use of natural elements, thus reflecting the harmony and unity between man and nature. Likewise, many natural elements can be properly used in the creation of digital illustration art of information age. Unlike traditional illustration, which creates virtual through cloth, paint, and so on, digital illustration mainly realizes virtual through various digital techniques and devices.

Of course, the virtual aspect of digital illustration also has the following two meanings: one meaning is “simulation.” Digital illustration presents reality to the viewer through digital technology, which can only simulate a visual image of reality on the screen. The other meaning is “breakthrough.” Due to the strong simulation ability of digital illustration, digital illustration can go beyond the confines of “reality” and create images that do not exist in reality at will. Interactivity is also one of the characteristics of digital technology and the direction of digital illustration art. Traditional illustration is a static presentation, information dissemination is one-way and passive, and interactivity is not comparable to digital illustration. The interactivity of digital illustration is mainly reflected in the following ways: first, the digital illustration is made more dynamic through digital technology, which makes the audience feel as if they are in the

scene when viewing it. Second, digital technology has built a free and open platform for digital illustration, breaking the limitation of time and space, so that viewers can enjoy illustration art anytime and anywhere. Third, the audience has the opportunity to give their own understanding and assessment of the art of illustration. Thus, digital illustration has an interactive, two-way, peer-to-peer exchange of information [7].

As digital technology continues to develop, the scope of application of digital illustration artworks becomes broader and broader. The new digital technology provides a strong support for the creators. The artistic concept and thinking of the creators have also become more extensive. The current digital illustration art shows a diversified development trend. On the one hand, in the development of information society, the use of digital illustration artworks has become a habit. At present, different types of illustrations have different illustrators, which is a reflection of the professionalism of digital illustration. At present, some online games are more popular. Digital illustration has also started to enter the game field and has a surprising market development space. In addition, during the development of digital illustration art, traditional elements such as color, culture, and pattern have been incorporated into digital illustration art, and over time, have taken on a deeper cultural and spiritual dimension. For this reason, in the subsequent social development process, the art of digital illustration needs to be given a diversified development.

In terms of visual expression, the vectorized style of images is the unique artistic style of digital illustration art compared to traditional illustration art. Graphics with vectorized visual characteristics can be scaled infinitely without distortion. Its lines are smooth and the graphics are complete and highly accurate. In particular, transparency and different overlay modes can create artistic styles with industrialized products. As a result, vector technology has become the best way to convey information in mass media such as printing, packaging, framing, publicity, advertising, posters, web, and video [8]. The traditional illustration technique of drawing is a linear creation and reworking on paper media with various brushes, while digital illustration is created in a more integrated way, with the emergence of the concept of nonlinear "synthesis." In computer graphics software, the drawing material is redesigned and reprocessed, which not only greatly improves the efficiency of illustration creation but also enriches the expression form of illustration. The clarity of the digital illustration pattern directly affects the quality of the illustration. The use of digital tools has made art and design easy, and this development of high technology has made everyone an artist. The "threshold" of mediocrity has led to an increase in the number of practitioners, while the quality of drawings has decreased significantly. Therefore, there is a need for rigorous monitoring and assessment of the quality of digital illustration patterns.

2.2. Research Status of Image Quality Assessment. Image quality assessment is a measure of the visual quality of an image [9]. Digital images are disturbed by many factors during acquisition, compression storage, and transmission, resulting in distortion or degradation, which affects the human visual experience or the postprocessing effect of the

image. Only with a correct assessment of the image quality, subsequent enhancement or control methods can be determined. Depending on whether or not there is human involvement, it can be divided into subjective image quality assessment and objective image quality assessment. Subjective quality assessment relies on human subjective perception to judge the quality of images. Since different people may have different perceptions of image quality, it is common practice for multiple people to evaluate distorted images and then take the average value. Objective image quality assessment requires the use of computers to build mathematical models. Then, to calculate and output digital measurement results, a high degree of consistency is required between objective image quality assessment results and subjective quality scores [10–13].

According to the presence or absence of reference information, digital image quality assessment methods can be divided into three categories: full-reference image quality assessment (FR-IQA) [14], reduced-reference image quality assessment (RR-IQA) [15], and no-reference image quality assessment (NR-IQA) [16]. The FR-IQA model and RR-IQA model calculate the visual quality of distorted images by analyzing the visual features of the images and quantifying the differences between the reference images and the distorted images. Compared with the FR-IQA model and RR-IQA model, the NR-IQA model does not require any reference image information for calculating the visual quality of distorted images and has a wider application prospect in practical systems. In this study, we focus on the current research status of NR-IQA model.

Xue et al. [17] proposed an NR-IQA method for quality-aware clustering based on image blocks. First, the quality score of each image block is calculated by the FR-IQA algorithm, and all image blocks are divided into L major classes according to their quality score ranges. Then, the major image blocks are divided into K subclasses by the K-means algorithm based on the extracted structural features. Among them, each subclass corresponds to a cluster center, namely, an image block (structural features and visual quality score). Given a distorted image, we first extract the image block and calculate the distance between the image block and the cluster center of each subclass in L major classes. The scores of the image blocks are then calculated by fusing the visual scores of the distance from the center of the smallest cluster in each major class. Finally, the visual quality scores of the distorted images were obtained using the averaging weighting strategy. Ye et al. [18] proposed an unsupervised IQA model BLISS (blind learning of image quality using synthetic scores). The authors obtained a single synthetic quality score by combining multiple valid FR-IQA models and used the synthetic quality score with high correlation as a subjective score approximation to further train the corresponding IQA model. Among them, the fractions calculated by different FR-IQA methods were fused by unsupervised sorting aggregation and the corresponding performance of the synthesized obtained quality fractions exceeded the performance of a single FR-IQA method. For screen images, Gu et al. [19] proposed a reference-free screen

image quality assessment method. By extracting image features related to four aspects, including image complexity, screen content statistics, global brightness, and detail sharpness, a quality score is calculated using an existing high-performance full-reference screen image quality assessment method. The quality score is used as the training dataset label to obtain the final screen image quality assessment model.

The unsupervised IQA model based on traditional machine learning algorithms measures the difference in image quality by constructing a statistical model. The unsupervised IQA model based on deep learning achieves the mapping between image and quality scores by constructing effective training data. This type of method solves the problem of lack of training data in data-driven models to a certain extent, and the performance is much higher than that of NR-IQA models based on traditional machine learning.

KangCNN [20] model was proposed by Kang et al. It is the first model that employs the convolutional neural network (CNN) to solve the NR-IQA problem. It incorporates feature extraction and fractional regression into a unified framework for implementation. CNN has 5 layers, including 1 convolutional layer, 1 pooling layer, 2 fully connected layers, and 1 output node layer. The quality score of the whole image is based on the local quality assessment score, which is obtained by taking the average of the scores. The pooling layer performs maximum pooling and minimum pooling operations on the full-size feature maps of the convolutional layer respectively to obtain two feature vectors of dimension 50. The more popular ReLU unit is used between the fully connected layers. The loss function used is similar to SVR and can be seen formally as SVR taking ϵ to zero. DeepIQA proposed by Bosse et al. [21] is also an IQA model based on an end-to-end framework. DeepIQA combines full-reference IQA tasks and NR-IQA tasks in a single network implementation. Full-reference IQA is trained using the Siamese network, and a branch of the Siamese network can be used for NR-IQA with minor modifications. DeepIQA has achieved good results on both artificially simulated distortion datasets and natural distortion datasets.

Ma et al. proposed a bilinear pooling-based CNN structure for NR-IQA [22]. The network consists of two branching networks and a bilinear pooling module. High-quality images from the dataset are used to synthesize different types of distorted images with different degrees of distortion, and the branch network is trained with classification. Another branch network uses VGG16, which is pretrained on ImageNet datasets to improve the perception of natural distortion across the network. Finally, the bilinear pooling module is used to fuse the fully connected layer features of the two networks as the depth features of the images, and then, the mapping relationship between the depth features and the quality scores is fitted. This method achieves the highest performance on both synthetic distortion and natural distortion IQA datasets, bringing new ideas to the current NR-IQA research efforts.

Although the current NR-IQA method can achieve good test results in artificial simulation datasets, it is not very scalable. So, how to design IQA models with robustness and

apply them to the task of digital illustration quality assessment deserves further research.

3. Quality Assessment of Illustration Patterns Based on Multifeature Fusion

3.1. Information Entropy. The convolutional neural network (CNN) is a kind of common deep learning network. In this study, the IQA-CNN model combined with this network and image quality assessment (IQA) method is selected as the deep learning network to realize the reference-free assessment of digital illustration pattern quality. In the process of creating the training set of IQA-CNN model, the dataset is usually divided by the chunking process, and each chunk is labeled with the quality score of each chunk, so as to effectively solve the problem of the lack of the number of samples in the training set. The information entropy of the illustration pattern is rich in information about the structure of the image, and it is possible to measure the sharpness of part of the illustration pattern by such information. In general, it is customary to use the high acuity part to evaluate the image quality. Thus, the accuracy of the annotation is improved by the information entropy annotation of each chunk after chunking. Suppose the illustration pattern is represented by $I(x, y)$ and the image has k levels, then its information entropy can be expressed as follows:

$$H = - \sum_{i=0}^{k-1} P_i \log_{10} P_i, \quad (1)$$

where P_i represents the percentage of pixels with gray value i in the image, which is set at $P_i = 0, P_i \log P_i = 0$. This information entropy is used to label the information content of each chunk, which can represent the quality of each chunk.

3.2. Normalization of Fused Multipartition Features. The improved IQA-CNN model obtained by introducing information entropy into the IQA-CNN model is shown in Figure 1. Before convolution, the image chunks are preprocessed with local normalization, which is helpful to remove the redundant features of the image that are weakly associated with the image quality.

The local normalization method used is as follows:

$$\begin{aligned} \hat{I}(i, j) &= \frac{I(i, j) - \mu(i, j)}{\sigma(i, j) + 1} \quad i \in [1, M], j \in [1, N], \\ \mu(i, j) &= \sum_{k=-K}^K \sum_{l=-L}^L \omega_{k,l} I(i+k, j+l), \\ \sigma(i, j) &= \sqrt{\sum_{k=-K}^K \sum_{l=-L}^L \omega_{k,l} [I(i+k, j+l) - \mu(i, j)]^2}, \end{aligned} \quad (2)$$

where $I(x, y)$ is a distorted image. M and N represent the height and width of the image, respectively. P and Q represent the size of the normalized window, and the maximum value cannot exceed the size of the input image. ω is the

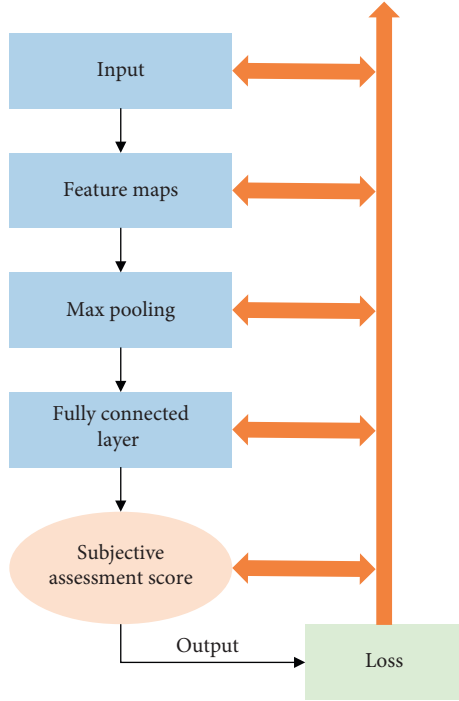


FIGURE 1: Improved IQA-CNN model.

weight of the Gaussian function window, and a window of size 3×3 is used in this study. Using 40 convolution kernels of size 7×7 on a 32×32 input image block with a sliding step of 1 for convolution, 40 feature maps of size 26×26 are obtained. Then, in the sampling layer, 40 feature maps are processed using the nonoverlapping large window sampling method. Unlike the small window sampling approach for classification tasks, this study uses 26×26 window sampling to map each feature map to an activation unit. In the output layer, the 40 output values are used as the input values of the next layer. In this study, two fully connected layers of 400 and 100 are used, and ReLU is used as its activation function, which helps to speed up the decrease of prediction error during training. Finally, the quality values of the images are obtained by a nonlinear regression loss function network based on information entropy, and the average of the quality of each chunk is taken to generate the quality fraction of the large image. The information entropy of each large image corresponding to a chunk is normalized as in equation (3) and used as the importance weight W of each chunk in the training process. $N = 100$ indicates that each large image is divided into 100 nonoverlapping chunks:

$$W(k) = \frac{H}{\sum_{i=1}^{N^2} H}. \quad (3)$$

According to equation (3), the different distortion type plots in Figure 2(a) are chunked and their importance weights W are calculated. Figure 2(b) can be obtained by visualization. The importance weights W in Figure 2(b) are represented by different colors. From blue to red, the darker the color, the higher the weight (electronic version).

Comparing Figures 2(a) and 2(b), it can be found that in the case that the whole image in Figure 2(a) is blurred, and the chunks with rich contents are still able to obtain higher weights in Figure 2(b). This indicates that the weights obtained by equation (3) can locate the content features of the image more accurately in the case of image distortion. Therefore, the chunks with higher weights are more representative in the training process of the convolutional network.

3.3. Loss Function. Since the higher the weight of the image chunk, the higher its representation. Therefore, the loss function within the initial convolutional network is transformed as follows:

$$L = \frac{1}{N} \sum_{n=1}^N \omega_n \|f(x_n) - y_n\|_{l_2}, \quad (4)$$

where label value of each block of image is represented by y_n . Input image block is represented by x_n . The convolutional network prediction score of x_n is represented by $f(x_n)$. In this way, when the information entropy is high, the block fraction that can better represent the large image quality deviates from the actual label value, and the convolutional network will generate a higher loss function than the original due to the high weight assigned by these blocks, so as to compensate for the fraction deviation. The adjustment of the loss function can effectively enhance the role played by the chunks that can represent the whole image features in the training process, while weakening the role of the less representative chunks and making the training process more effective.

3.4. Algorithm Steps. The process of illustration pattern quality assessment algorithm with multifeature fusion proposed in this study is detailed in Figure 3. The specific process is as follows:

- (1) Normalized preprocessing of the digitized illustration patterns in the input dataset and dividing the images into several $N \times N$ chunks with no overlap between the chunks.
- (2) The IQA-CNN model is trained to optimize the parameters of the model.
- (3) The steps in the training stage are as follows: each subjective quality score is assigned to each image block according to the standard score of the original image. The training samples (x_n, y_n) are input to the QA-CNN model and the objective function used is shown in equation (5). The fraction function predicted by the network with weight ω is represented by $f(\omega, x_n)$. The objective function $\omega' = \min J$ is minimized by combining the back propagation method with the gradient descent method. The normalized information entropy of all image chunks is used as the weight. This weight is used to adjust the loss function to increase the weight of the chunks that are more representative of the overall image

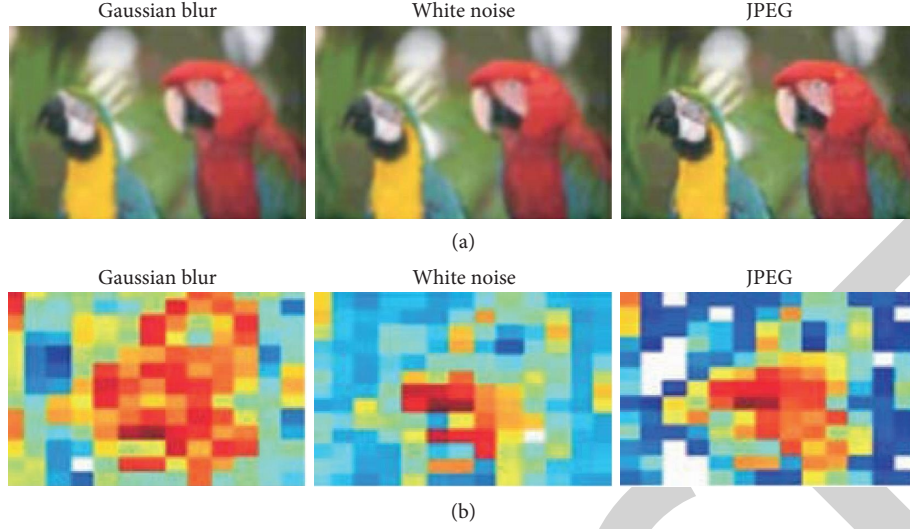


FIGURE 2: Distorted illustration patterns and their normalized information entropy. (a) Distorted illustration patterns. (b) Normalized information entropy corresponding to different distortion patterns.

quality and to optimize the parameters of the IQA-CNN model.

$$J(\omega; x_n, y_n) = \frac{1}{N} \sum_{n=1}^N \|f(\omega, x_n) - y_n\|^2. \quad (5)$$

- (4) Tests are performed on any given image. The image quality score is given directly by the IQA-CNN model in this study, and then, a weighted average is used to generate the predicted quality of the large image.

4. Experiments

4.1. Experimental Preparation. The dataset used in the training process of the network is the illustration pattern dataset collected by network retrieval. The dataset contains 1000 distorted images (from 20 reference images) with distortion types of JPEG compression (JPEG), white noise (WN), and Gaussian blur (GB). The database provides DMOS (differential mean opinion score) values for each image. The values range from 0 to 100, with higher DMOS values indicating lower image quality. The dataset is divided according to a ratio of training set:test set = 80%:20%. All comparison experiments in this study are based on Windows 10 CPU Intel Core i7 3.2 GHz with 64 GB of RAM and 1 Nvidia RTX2080Ti graphics card.

Judging the performance of the image quality assessment algorithm requires experimental validation on a database, mainly by calculating the correlation between the objective quality scores of the assessment algorithm for distorted images and their corresponding subjective quality scores. If the correlation degree between them both is high, the algorithm performs better. The evaluation metrics used in this study are as follows:

4.1.1. Linear Correlation Coefficient. The linear correlation coefficient (LCC) aims to calculate the linear correlation

between two variables, as shown in equation (6). x_i denotes the quality score predicted by the algorithm for the i th image, y_i denotes the subjective quality score corresponding to the i th image in the database, \bar{x} is the average of the algorithm's prediction scores $\{x_1, x_2, x_3, \dots, x_n\}$ for all test images, \bar{y} is the average of the subjective quality fraction $\{y_1, y_2, y_3, \dots, y_n\}$ of all test images in the database, and n represents the number of test images. The linear correlation coefficient, as an index to evaluate the accuracy of the algorithm, is mainly used to calculate the linear correlation between the quality fraction predicted by the algorithm and the quality fraction in the corresponding database:

$$LCC = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 (y_i - \bar{y})^2}} \quad (6)$$

4.1.2. Spearman's Rank-Order Correlation Coefficient. Spearman's rank-order correlation coefficient (SROCC) measures the closeness of the association between two variables, as shown in equation (7). $r_i^{(x)}$ is the ranking position of the i th image in the sequence after x_i has been arranged into a sequence by size and $r_i^{(y)}$ is the ranking position of the i th image in the sequence after y_i has been arranged into a sequence by size:

$$SROCC = \frac{6 \sum_{i=1}^n (r_i^{(x)} - r_i^{(y)})^2}{n(n^2 - 1)}. \quad (7)$$

4.1.3. Pearson Linear Correlation Coefficient (PLCC). The operator of the PLCC index is shown in equation (8). In this equation, the mean value obtained after averaging the algorithm-predicted quality scores of all test images is expressed as \bar{x} . The mean value obtained after averaging the subjective quality scores of all test images is expressed as \bar{y} :

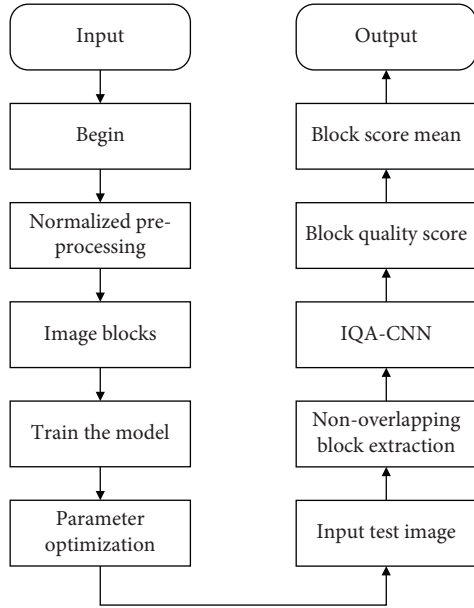


FIGURE 3: Overall algorithm implementation flow.

$$\text{PLCC} = \frac{\sum_{i=1}^N (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^N (x_i - \bar{x})^2 \sum_{i=1}^N (y_i - \bar{y})^2}}. \quad (8)$$

4.2. Effect of the Number of Convolution Kernels on Model Performance. The evaluation performance of the algorithm was examined for different numbers of convolutional cores from 10 to 70 to determine the number of convolutional cores of the algorithm. The results are shown in Figure 4. When the number of convolutional cores ranges from 10 to 40, the values of SROCC and PLCC show an increasing trend, but when the number of convolutional cores reaches 50, the values of both evaluation performance indicators of this algorithm decrease gradually. It can be seen that the number of convolutional kernels has a direct influence on the evaluation performance of this algorithm, and the number of convolutional kernels is selected as 40 for this algorithm.

4.3. Effect of Sampling Step Size on Model Performance. The evaluation performance of the algorithm is also affected by the sampling step length selected when sampling the image chunks, so the evaluation performance of the algorithm is tested for 10 sampling steps in the range of 30 to 300. The obtained test results are shown in Figure 5. The evaluation performance of this algorithm is the highest when the sampling step length is 90, and then, the evaluation performance of this algorithm decreases as the sampling step length continues to grow. The reason is that the image feature information that can be used to evaluate the image quality decreases with the increase of the sampling step, so the higher the step size the lower the evaluation performance of this algorithm. Therefore, the sampling step length of this algorithm is selected as 90.

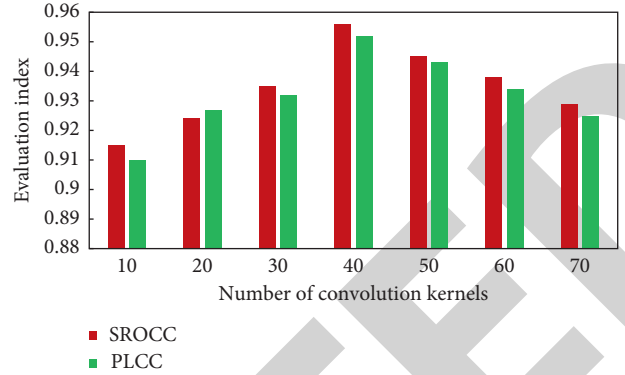


FIGURE 4: Effect of the number of convolution kernels on the model.

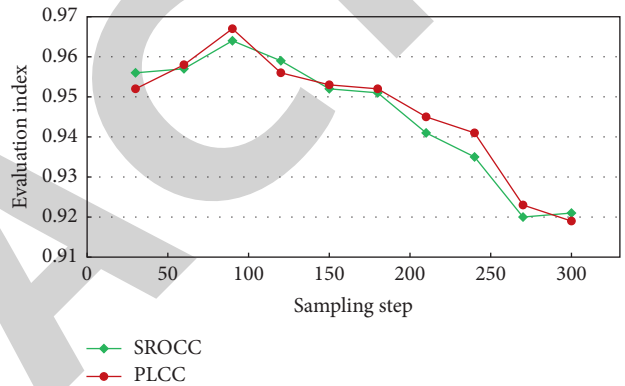


FIGURE 5: Effect of different sampling steps on model performance.

4.4. *Evaluation Performance Test.* With the selected number of convolution kernels and sampling steps, the algorithm proposed in this study is applied to evaluate the quality of digital illustration patterns in the dataset. In order to present the evaluation effect of this algorithm more clearly, three experimental images are presented as examples of these three illustration patterns. The quality of the three experimental images is demonstrated by DMOS scores, and the obtained subjective observations are compared with the actual evaluation results of each method to further test the evaluation effect of this algorithm. The three digital illustration patterns are shown in Figure 6. The results of the quality evaluation scores of the three experimental images derived from the four algorithms are listed in Table 1. Combining Figure 6 and Table 1, it can be concluded that the visual quality of the three experimental images, from high to low, is defined once for images A, B, and C, respectively. The quality evaluation scores of BLISS [18] algorithm for the three images are close to each other. The quality evaluation scores of KangCNN [20] and DeepIQA [21] for images A and C are higher, while the evaluation score of image B is lower. The quality evaluation scores of the three experimental images by the algorithm in this study are similar to the visual subjective observation results from the highest to the lowest order. This indicates that the evaluation results obtained by this algorithm are more reasonable, with higher evaluation accuracy, and have higher practical application value.

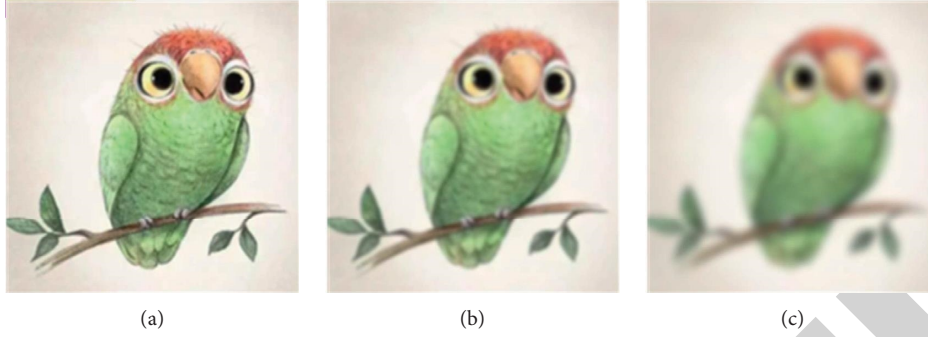


FIGURE 6: Distorted digital illustration pattern. (a) DMOS = 68.743. (b) DMOS = 53.271. (c) DMOS = 42.197.

TABLE 1: Evaluation effects of different algorithms on distorted digital illustration patterns.

| Model | Image A | Image B | Image C |
|----------|---------|---------|---------|
| BLISS | 49.328 | 47.211 | 44.269 |
| KangCNN | 75.989 | 69.403 | 35.092 |
| DeepIQA | 77.398 | 65.804 | 37.925 |
| Proposed | 65.438 | 50.107 | 38.721 |

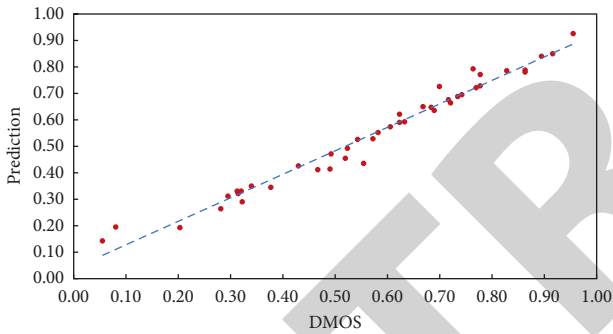


FIGURE 7: GB + JPEG and GB + WN mixed distortion.

TABLE 2: Comparison of LCC and SROCC with different distortions.

| Distortion | LCC | SROCC |
|----------------|-------|-------|
| JPEG | 0.875 | 0.899 |
| WN | 0.894 | 0.874 |
| GB | 0.826 | 0.865 |
| JPEG + WN | 0.903 | 0.901 |
| JPEG + GB | 0.912 | 0.937 |
| WN + GB | 0.905 | 0.912 |
| JPEG + WN + GB | 0.943 | 0.956 |

Figure 7 shows the predicted quality scores versus the original DMOS for both GB + JPEG and GB + WN mixed distortions. It can be seen that there is a linear correlation between the predicted scores of distorted images and the original DMOS values. Table 2 lists the evaluation scores of the proposed model for different distortion cases in this study. A better image quality evaluation model is to have a higher LCC and SROCC, and the method in this study achieves the desired results.

5. Conclusions

With the increasingly widespread use of computer technology, traditional illustration is gradually transforming into digital illustration. This study mainly analyzes the characteristics and development trend of digital illustration and proposes a quality evaluation method of digital illustration based on the deep neural network to solve the problems of backward evaluation methods and poor accuracy. Specifically, this study proposes a multifeature fusion method for reference-free pattern evaluation, which fuses the information entropy of multiple chunked features in a single image and trains IQF-CNN networks using features and image subjective quality to obtain an objective quality assessment model. The experimental results on the digitized illustration pattern dataset show that this model can achieve high accuracy assessment of digitized illustration patterns, and the results obtained are more reasonable and reliable. In our future research program, we plan to use recurrent neural networks and knowledge graphs for online simulation studies of illustration patterns for digital art design.

Data Availability

The datasets used during the current study are available from the author upon reasonable request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

References

- [1] B. Ji, Y. Li, D. Cao, C. Li, S. Mumtaz, and D. Wang, "Secrecy performance analysis of UAV Assisted Relay transmission for Cognitive network with Energy Harvesting," *IEEE Transactions on Vehicular Technology*, vol. 69, no. 7, pp. 7404–7415, 2020.
- [2] X. Lin, J. Wu, S. Mumtaz, S. Garg, J. Li, and M. Guizani, "Blockchain-based on-Demand computing Resource trading in IoV-Assisted Smart City," *IEEE Transactions on Emerging Topics in Computing*, vol. 9, no. 3, pp. 1373–1385, 2021.
- [3] J. Li, Z. Zhou, J. Wu et al., "Decentralized on-Demand Energy supply for Blockchain in Internet of Things: a Microgrids approach," *IEEE Transactions on Computational Social Systems*, vol. 6, no. 6, pp. 1395–1406, 2019.

Retraction

Retracted: Key Technologies of Digital Protection of Historical and Cultural Heritage Based on Virtual Reality Technology

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] W. Zhang, "Key Technologies of Digital Protection of Historical and Cultural Heritage Based on Virtual Reality Technology," *Mobile Information Systems*, vol. 2022, Article ID 1598160, 8 pages, 2022.

Research Article

Key Technologies of Digital Protection of Historical and Cultural Heritage Based on Virtual Reality Technology

Weiguo Zhang 

School of Animation, Shijiazhuang University of Applied Technology, Shijiazhuang, Hebei 050081, China

Correspondence should be addressed to Weiguo Zhang; 2015000744@sjzpt.edu.cn

Received 13 May 2022; Revised 3 June 2022; Accepted 7 June 2022; Published 25 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Weiguo 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.

Due to the increasing progress of digital technology in recent years, the protection, inheritance, development, and utilization of historical and cultural resources have become more and more integrated into it, and it has become an ideal way. At present, many countries and regions have carried out relevant research projects. With the change of the living conditions of cultural heritage and the rapid development of sci & tech, many traditional protection methods are no longer suitable and need to be replaced by new protection methods. Digital protection technology is one of the fastest developing and most concerned. With the help of virtual reality (VR) technology, it presents the essence of Chinese culture for thousands of years and comprehensively combines the characteristics of all viewpoint with traditional Chinese culture. Select the representative Chinese traditional culture as the research direction, and analyze the cultural characteristics contained in the Chinese traditional culture. In this paper, Harris operator is used to extract the feature points of the images, and two registered images are calculated according to the affine transformation coefficient. The images after affine transformation are bilinear interpolated and weighted smoothed according to the adjacent position of the overlapping area to realize the seamless mosaic design of the images and the forward and backward projection algorithm of cylindrical panoramic images. And study the artistic expression of 3D panoramic image acquisition. Based on the analysis and experiment, it can be obtained that after calculation, the average spatial data acquisition efficiency can reach 61.8%. In practice, the average display effect can reach 60.4%.

1. Introduction

Due to the increasing progress of sci & tech, communicators can build a surreal world based on real scenes and cultural background with the help of VR technology and depict the stories that have happened in an artistic and virtual narrative way, and the audience can experience the value and connotation of traditional ancient architectural culture with the help of VR equipment. This communication mode is very different from the cultural communication under the traditional ordinary video communication mode [1, 2]. Due to the increasing progress of VR technology and the rationality of its application content, in practical work, high-resolution images beyond the visual angle of human eyes are used, while the visual angle of ordinary cameras cannot meet the needs [3]. For example, due to the limitation of distance, some super-large objects cannot be photographed in one photo, which is particularly prominent in the field of

aerospace photography, and the demand for real-time rendering technology of realistic graphics has increased dramatically.

In order to realize the correct expression of cultural symbols, the combinations of model structure, related structure, and internal information are widely used [4, 5]. The model includes not only the external content, but also the internal environment, texture, and structure of materials, thus realizing the true presentation of culture [6, 7]. When the related buildings need directional restoration work, virtual models can be used for dynamic display, which can effectively reduce the possible uncertainties caused by the restoration work, reduce the risks and crises, and realize the effective protection and scientific management of ancient buildings [8, 9]. It can be seen that VR has the characteristics of multi-perception, immersion, interaction, and conception. It will be of great help to apply these characteristics to the protection of cultural heritage. In the current

development of cultural undertakings and cultural industries, cultural resources have received unprecedented attention.

As the precious wealth of human civilization, historical and cultural resources are the essence of our country and nation, and their protection and development have attracted the common attention of all countries in the world in recent decades [10, 11]. The protection and utilization of foreign historical and cultural resources have been deeply practiced and studied. "Cultural industry and information industry are two super-industries in modern society and an important symbol of a country's soft power [12, 13]. Digital technology has given birth to the comprehensive convergence and integration of information industry and cultural industry, making the connection between the two industries completely beyond the traditional meaning [14]. With the development of information industry, the cultural industry has obtained a new interpretation and development opportunity; the development of cultural industry provides rich digital cultural content for the information industry" [15]. However, the above research does not solve the current problem of digitization of historical and cultural heritage. Therefore, this paper proposes the following innovations:

- ① Put forward the research of artistic expression of 3D panorama: on the basis of objective representation of 3D panorama, study the artistic expression of 3D panorama image and the application of HDR high dynamic density image in 3D panorama. In the technology, the commonly used panorama technology will be studied. The key technologies of image mosaic mainly include image matching and image synthesis.
- ② Research the collection method of panorama, and focus on analyzing the construction process of 360-degree cylindrical panorama space. The feature points of the image are extracted by the Harris operator, and the two registered images are calculated according to the affine transformation coefficient. The affine transformed image is subjected to bilinear interpolation and weighted smoothing according to the adjacent position of the overlapping area to realize the seamless stitching design of the image and realize the columnar design. Front and back projection algorithm for surface panorama images.

The chapters of this paper are arranged as follows: the first chapter is the introduction, which discusses the background and significance of the topic, and expounds the innovation of this paper. The second chapter mainly combines the research results of key technologies of digital protection of historical and cultural heritage based on virtual reality technology at home and abroad, and puts forward the innovative results and research ideas of this paper. The third chapter is the method part, which deeply discusses the application and principle of relevant algorithms. On the basis of previous research results, combined with the innovation of this paper, this paper puts forward the development and research model of new digital protection key

technologies. The fourth chapter mainly discusses the experimental part of algorithm application. Through the experimental results, the technical model is established on the basis of sorting out the data. The fifth chapter is the conclusion, which summarizes the research results of this paper.

2. Related Work

Liu G proposed that with the help of VR technology, cultural forms such as ancient buildings, which are difficult to spread across time and space in daily life, can not only make the audience feel immersive, but also break the boundary between time and space, so that the audience can feel the cultural connotation of ancient buildings through ancient and modern times. This plays a very important role in strengthening patriotic education and improving national pride and cohesion [16]. Hong l believes that in practical application, GBR technology has many deficiencies both from the current computer processing capacity and from the perspective of developers. On the one hand, the cost of modeling and rendering is very large. When the actual scene is quite complex or needs to provide quite a lot of details, this method is inadequate. On the other hand, the real-time rendering speed is not satisfactory, and the rendering speed is inversely proportional to the scene complexity and rendering quality [17]. Phoon, Yap et al., and others believe that model construction is the first important link of digital protection. Effectively input the content into the software system and synchronously build cultural heritage with different software. In order to ensure the rationality and accuracy of the system, contacting each module is the focus of the model, and the expression content is clear, efficient, and accurate [18]. The research of Ren, Du, Feng, etc., shows the characteristics of virtual scene modeling and the main technical indexes for evaluating this modeling process, introduces and compares several modeling methods at present, and puts forward the hybrid modeling method applied in this paper. At the same time, by comparing the characteristics of the popular VR modeling software, the modeling software and real-time roaming driver software are selected [19]. Li and Hou believe that the image of the real scene is directly used as the representation of the virtual scene to truly reproduce the visual information of the real scene. The quality of the generated scene view has nothing to do with the complexity of the scene, but only with the resolution of the image to be displayed and the corresponding generation algorithm. The calculation amount of the view generation algorithm is small and can be completed in real time on the workstation and PC [20]. Zhang proposed that it should be emphasized that historical and cultural resources are a spiritual element. The key to historical and cultural resources lies in "historical culture." "Historical culture" contains at least three meanings: culture in history; culture with history as the core; and history and culture. Historical and cultural resources refer to the things that happened in the past of human beings and have an influence to become the spiritual elements that meet people's spiritual needs and the spiritual elements that are attached to the material [21]. Pletz C believes that the existing situation of intangible cultural

heritage is even worse. Industrialization and modernization have had a subversive impact on traditional culture, and the urbanization process has made the folk culture produced under the traditional farming civilization desperate. The modern education system has changed the environment and thinking mode of children's childhood growth, while the current social environment has also changed the traditional way of life and entertainment of the masses, which has greatly shaken the survival foundation of intangible cultural heritage [22]. Zhao C believes that the effective combination of augmented reality technology and the digital development and utilization of intangible cultural heritage can fully highlight and give full play to the complementary relationship between the two, promote the effective full interpretation, display dissemination of intangible cultural heritage, and finally realize the rational development, utilization, and protection of intangible cultural heritage [23]. Zhanjun proposed that the "image-based" VR technology gradually came to the fore. Image-based rendering (IBR) technology proposed in the 1990s has become a research hotspot in recent years. 3D panorama has attracted more and more attention due to its strong realism and strong interactivity [24]. Zhong put forward the research and construction of the theoretical framework of the development mode (3) of cultural digital implantation based on augmented reality technology. Based on the principle of augmented reality technology, with the basic idea of cultural digital implantation in the existing material media, and the comprehensive application of digital technology and information technology and other related fields, the theoretical framework of cultural digital implantation development model is constructed [25].

Based on the research of the abovementioned related work, this paper determines the positive role of the research field of digital protection key technologies of historical and cultural heritage based on VR technology, constructs the algorithm model of digital protection key technologies optimized by algorithm, and makes in-depth analysis and research on the acquired and collected data by using VR technology, so as to make more effective use of the data and excavate the valuable hidden behind the data.

3. Methodology

3.1. Overview and Analysis of Related Theories

3.1.1. The Concept and Connotation of Historical Heritage. Cultural digital implantation refers to the process of using digital technology to process cultural content, transforming cultural content into digital form, adhered to, and integrated into a certain carrier.

To explain the concept of cultural digital implantation, this paper divides the ways of cultural implantation into physical ways and digital ways. For example, China has a large number of intangible cultural heritages that have lost their inheritance before they have time to protect. If all inheritors can consciously use digital means, at least some can be retained. Although many inheritors are out of touch with the times, there are some simple ways to do it. Even a

few photos and simple videos taken by mobile phones can be used as the basis for the existence of this culture. Compared with traditional methods, this form of protection has many advantages because the traditional data storage cost is high and the capacity is low. Digital archiving is just the opposite, with low cost and explosive growth of stored information. Information must rely on digital technology. As the cultural heritage itself is facing an endangered situation, it is an important strategy for the protection of cultural heritage to adopt advanced computer technology to combine its information sorting, monitoring, management, and decision-making, to make a true, systematic, and comprehensive record of precious, endangered, and historic cultural heritage, and to make virtual representation and establish permanent archives and databases. In foreign countries, it has become a fashion to use three-dimensional panorama to display the beautiful environment of the scenic spot, giving the audience an experience of being in the scenic spot. Combined with the guide map of the scenic spot, the audience can shuttle freely between the scenic spots and let the tourists feel the charm of the scenic spot in an all-round way.

Historical and cultural resources in the general sense belong to cultural resources in the final analysis and have all the characteristics of general cultural resources. However, apart from the characteristics of general cultural resources, historical and cultural resources have some characteristics of their own. Like objectivity, different from the subjective creation of realistic cultural resources, historical and cultural resources belong to the cultural resources formed and accumulated in the past. Like "historical past events," they have objective existence, and once they are formed, they will not be transferred by people's subjective ideas. Second is publicity. Historical and cultural resources "are not only the wealth of a region and a nation, but also the common wealth of human society." Then there is mystery. Because historical and cultural resources are usually formed in history, there is often a period or a long time interval from reality, which forms the mystery of "historical past." Cultural heritage is generally divided into two types: tangible cultural heritage and intangible cultural heritage. However, as historical and cultural resources, ancient books and cultural heritage have certain particularities, which are in essence between material and intangible, and are extremely rich and self-contained in a country like my country. Therefore, historical and cultural resources can be divided into three types: first, cultural relics and their derivatives; second, ancient books and their derivatives; and third, intangible cultural heritage and its derivatives.

3.1.2. Application of VR Technology in Digitalization of Cultural Heritage. Economy is the foundation of all development, and culture belongs to the category of superstructure. The change of economic foundation will inevitably lead to the change of cultural development. With economic globalization, the development of cultural globalization has become an inevitable trend. In order to create an environment for the user to feel immersive and immersed in it, one of the necessary conditions is to realistically display the

objects in the objective world in the VR roaming system as required. For example, it can display the characteristics of each ancient building and the three-dimensional images of the surrounding supporting environment. Figure 1 shows the basic process of virtual scene establishment.

To analyze the historical and cultural heritage based on VR technology, we must first analyze the VR. VR is a comprehensive technology that integrates information collection technology, image stitching technology, computer technology, and other technologies. According to the abovementioned related technologies, VR technology can realize a virtual world that is similar to or beyond the real world. Under the virtual world, the audience can not only feel the shocking visual experience, but also feel it from many aspects, such as hearing and even touch, so as to have the feeling of being there and achieve the real VR. VR technology can bring people very real experiences and feelings, which is determined by its own characteristics. The main features of VR include perception, immersion, interactivity, imagination, and autonomy.

Simply put, the image transformation model is intrinsically linked to the camera imaging geometry. They are different outward manifestations of the same type of concept. The transformation model between the captured images can be obtained from the imaging geometry of the camera; similarly, the information of the transformation model between the images can generally reversibly deduce the geometric posture of the camera during imaging. They are the mathematical basis of image registration and image stitching technology. As shown in Figure 2, it is the schematic diagram of world coordinate system and camera coordinate system.

Among them, the above coordinate system is represented based on $H_W M_W Z_W$, and its origin is generally located at a certain place in the shooting location; the H -axis is consistent with the horizontal direction of the heading, the M -axis is perpendicular to the H -axis, the Z -axis is up in the vertical direction, the H -axis is vertical, M -axis and Z -axis form a right-hand rectangular coordinate system. The camera coordinate system is represented by $H_C M_C Z_C$, with the optical center of the camera as the origin and the optical axis as the Z_C -axis. The plane determined by the H_C -axis and M_C -axis is parallel to the imaging plane. The camera is placed in the objective three-dimensional world with a certain attitude. Generally, the world coordinate system will not completely coincide with the camera coordinate system,

and there are rotation and translation relations. Under the secondary coordinates, these relations can be expressed by a matrix. The relationship between camera coordinate system and world coordinate system is as follows:

$$\begin{pmatrix} H_C \\ M_C \\ Z_C \\ 1 \end{pmatrix} = \begin{pmatrix} R & T \\ 0 & 1 \end{pmatrix} \begin{pmatrix} H_W \\ M_W \\ Z_W \\ 1 \end{pmatrix} = M \begin{pmatrix} H_W \\ M_W \\ Z_W \\ 1 \end{pmatrix}. \quad (1)$$

The subscript C represents the coordinates in the camera coordinate system, and the subscript W represents the coordinates in the world coordinate system, where $T, R, 0$ represents the rotation vector of $3 \times 1, 3 \times 3, 1 \times 3$, respectively. Figures 3 and 4 show the images of the camera coordinate system, the image plane coordinate system, and the image plane coordinate system.

In the above formula, the spatial coordinates need to be processed and transformed into European coordinates. The relationship between the above two coordinate systems in homogeneous coordinate system can be expressed by the following formula:

$$Z_C \begin{pmatrix} h_C \\ m_C \\ 1 \end{pmatrix} = \begin{pmatrix} f & 0 & 0 & 0 \\ 0 & f & 0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix} \begin{pmatrix} H_C \\ M_C \\ Z_C \\ 1 \end{pmatrix}. \quad (2)$$

In order to facilitate subsequent processing, this paper converts its representation, where (u_0, v_0) is the coordinate of O point in the coordinate system $O-uv$, and d_x, d_y represents the width and height of each pixel. The specific expression is as follows:

$$\begin{pmatrix} u \\ v \\ 1 \end{pmatrix} = \begin{pmatrix} \frac{1}{d_x} & 0 & u_0 \\ 0 & \frac{1}{d_y} & v_0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x_C \\ y_C \\ 1 \end{pmatrix}. \quad (3)$$

Through the above formula, the coordinate system relationship between the image plane and the world can be obtained through calculation. The expression is as follows:

$$Z_C \begin{pmatrix} u \\ v \\ 1 \end{pmatrix} = \begin{pmatrix} \frac{f}{d_x} & 0 & u_0 & 0 \\ 0 & \frac{f}{d_y} & v_0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix} \begin{pmatrix} R & T \\ 0 & 1 \end{pmatrix} \begin{pmatrix} H_W \\ M_W \\ Z_W \\ 1 \end{pmatrix} = K \begin{pmatrix} R & T \\ 0 & 1 \end{pmatrix} \begin{pmatrix} H_W \\ M_W \\ Z_W \\ 1 \end{pmatrix} = P \begin{pmatrix} H_W \\ M_W \\ Z_W \\ 1 \end{pmatrix}. \quad (4)$$

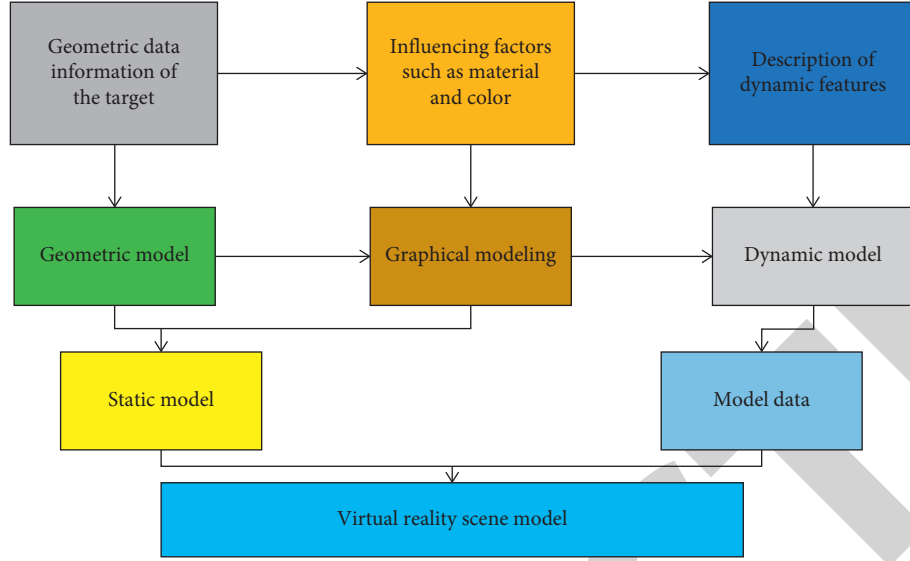


FIGURE 1: Basic flow of virtual scene establishment.

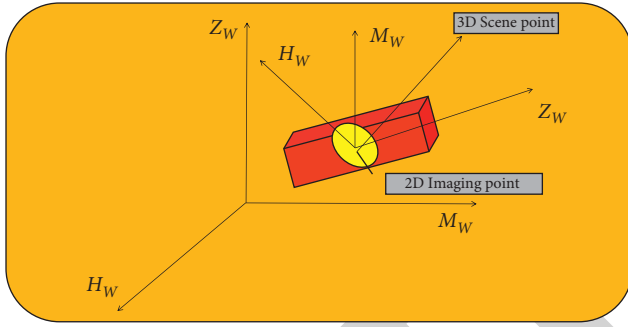


FIGURE 2: Schematic diagram of the world coordinate system and the camera coordinate system.

In the above formula, matrix P is called projection matrix, matrix K is only related to camera internal parameters, vector T , R is determined by the camera's position and direction relative to the world coordinate system, and they are called camera external parameters.

3.2. Focused Research on Digital Protection Technology. Image-based graphics rendering technology is a process in which the basic data are composed of discrete images sampled from the environment, and the continuous description of the environment is obtained by processing and organizing these image data. Generating scene pictures from different viewpoints based on some pregenerated images is an emerging research field, which changes people's traditional understanding of computer graphics. The panorama function characterizes all possible environmental mappings of a given scene; thus, it gives an accurate description of the scene in the form of images.

It can be described by parametric equation, which defines all the visible information in the scene at any time and within any wavelength range in any space. For any viewpoint $V(V_x, V_y, V_z)$ in space, any line of sight from this viewpoint

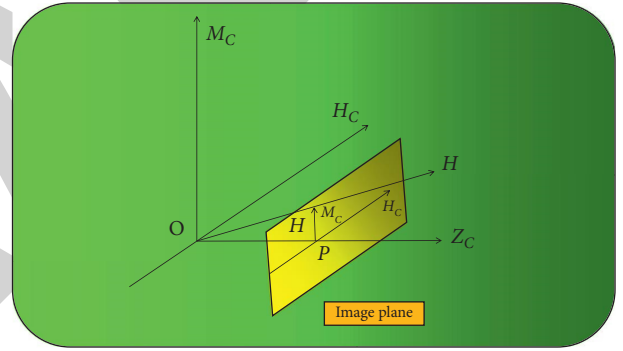


FIGURE 3: Camera coordinate system and image plane coordinate system.

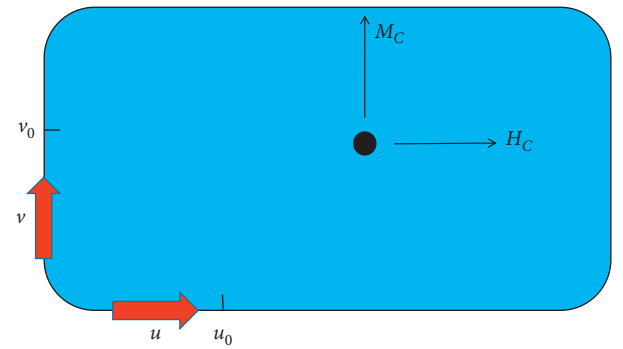


FIGURE 4: Images of two representations of the image plane coordinate system.

can be defined by spherical angle e and time t . If the recording wavelength is λ , the panoramic function at the viewpoint t at V time can be defined as $P = P(e, V_x, V_y, V_z, t)$. To generate a view of a given viewpoint in a specific direction, it is only necessary to substitute the viewpoint $V(V_x, V_y, V_z)$, the spherical angle e , and the time t into the panoramic function.

The corner points extracted based on Harris operator are used as feature points in image matching. It is simple and effective in calculation and very stable. It is a more stable point feature extraction operator compared with other operators under the conditions of image rotation, gray level, noise, and viewpoint transformation. The corner detection formula of Harris operator only involves the first-order difference of the image:

$$M = \frac{1}{2\pi\sigma^2} \exp\left(-\frac{x^2 + y^2}{2\pi\sigma}\right) \otimes \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix}. \quad (5)$$

Here, I_x, I_y represents the horizontal and vertical derivatives of the point in the image, respectively; g_x is the gradient in the x direction, g_y is the gradient in the y direction, and σ is the standard deviation of the Gaussian smoothing filter function.

After similar diagonalization of the above formula, the following is obtained:

$$M = \frac{1}{2\pi\sigma^2} \exp\left(-\frac{x^2 + y^2}{2\pi\sigma}\right) \otimes \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix} \Rightarrow R^{-1} \begin{bmatrix} \lambda_1 & 0 \\ 0 & \lambda_2 \end{bmatrix} R, \quad (6)$$

where λ_1, λ_2 is the eigenvalue of the quaternion matrix M . Each pixel corresponds to one such quaternary matrix. Here, R can be regarded as a rotation factor, and only the characteristic value λ_1, λ_2 can be used to analyze the variation, without affecting the variation components in two orthogonal directions. After diagonalization, the variation components of the two orthogonal directions are "extracted" and become λ_1, λ_2 . When both are small, it is defined as a flat area. When only one of the two is larger and the other is smaller, it is defined for the edge when both are larger. Table 1 shows the common camera focal length and corresponding viewing angle.

Assuming that the camera is in its normalized position, that is, the camera posture rotation matrix is identity matrix, then the optical axis Z coincides with the axis and is perpendicular to the Y -axis. The phase space coordinate of a point (X, Y) in the image is (X, Y, f) .

Transform such an image to the unit cylindrical surface, and the points on the cylindrical surface are represented by angle θ and height h , that is,

$$(\sin \theta, h, \cos \theta) \propto (x, y, f). \quad (7)$$

Accordingly, the image plane point coordinates can be mapped to the cylindrical coordinate transformation formula, and its expression is

$$\begin{aligned} x' &= s\theta = s \tan^{-1} \frac{x}{f}, \\ y' &= sh = s \frac{y}{\sqrt{x^2 + f^2}}, \end{aligned} \quad (8)$$

where s is the scaling factor, and for cylindrical stitching, s usually goes to the focal length of the camera. Generally, in

TABLE 1: Common camera focal lengths and corresponding viewing angles.

| Camera focal length | 14 | 16 | 24 |
|-----------------------|--------|-------|-------|
| Horizontal view angle | 81.20 | 73.70 | 53.24 |
| Vertical visual angle | 104.20 | 96.55 | 73.24 |

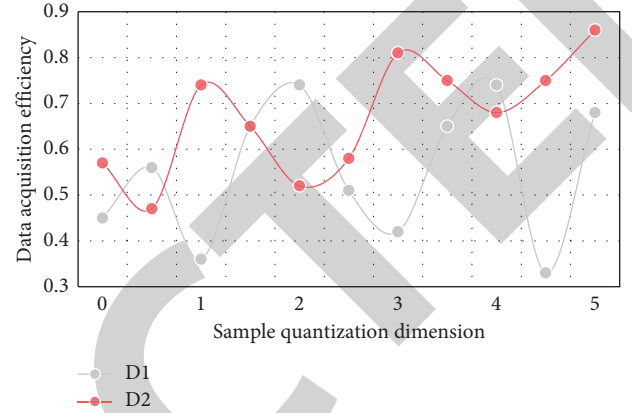


FIGURE 5: Analysis of spatial data acquisition efficiency.

order to prevent "holes" during transformation, it is necessary to use the inverse transformation form of cylindrical coordinate transformation. For the point (x', y') on the cylinder, when the focal length is f and the scaling factor is s , the corresponding image point coordinate (x, y) is

$$\begin{aligned} x &= f \tan \theta = f \tan \frac{x'}{s}, \\ y &= h \sqrt{x^2 + f^2} = f \frac{y'}{s} \sec \frac{x'}{s}. \end{aligned} \quad (9)$$

4. Result Analysis and Discussion

Through the above research and analysis, this paper has a relatively perfect system in theory. Next, the experimental analysis will be carried out in this part to prove the spatial digital model designed by the text. In order to build a scientific, reasonable, and feasible experimental conclusion system, this paper will analyze and experiment from four important aspects: spatial data acquisition efficiency, data acquisition accuracy, actual display effect strength, and digital loss rate. Figures 5 and 6 show the experiments. The results show the differences between the data sets D1 and D2 in terms of spatial data acquisition efficiency and data acquisition accuracy, and the data sets have a quantitative relationship of $D1 < D2$.

Through the above experimental analysis, it can be seen that in terms of virtual technology, the acquisition efficiency of spatial data is well reflected by the optimized processing in this paper, and the acquisition efficiency can be kept above 30% in different sample sets, which will also ensure that data interruption can be well avoided in the process of digitalization. After calculation, the average spatial data acquisition efficiency can reach 61.8%. When analyzing the

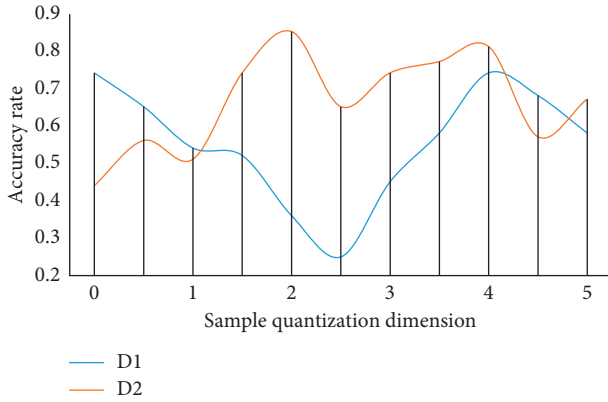


FIGURE 6: Data acquisition accuracy analysis.

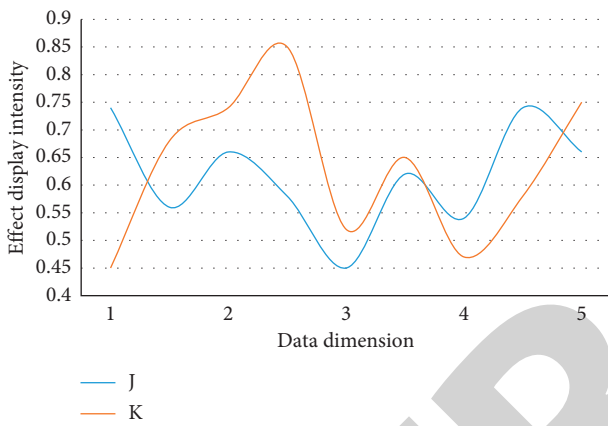


FIGURE 7: Analysis of the actual display effect strength.

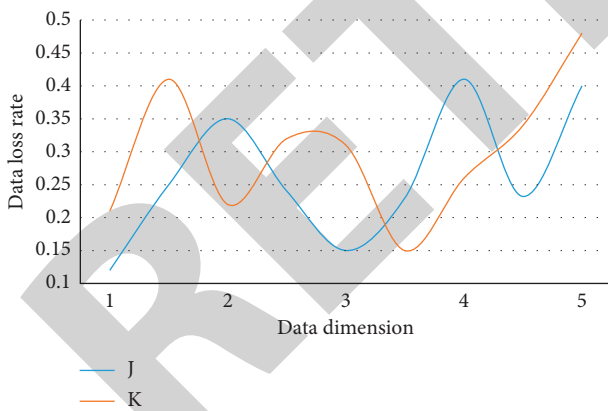


FIGURE 8: Digitization loss rate analysis.

accuracy of data acquisition, it is obvious that there are large fluctuations in the range of 1–3. This is due to the larger capacity of D2 in the data set, which inevitably leads to the increase of interference items. With the rapid expansion of data, this also causes the interference items to be unable to be reduced in time. But as the overall capacity increases, the interference term is diluted, so the accuracy returns to normal levels.

On the basis of the above experimental conclusion, the actual display effect intensity and digital loss rate are

analyzed, and *J* and *K* are experimental data sets, as shown in Figures 7 and 8.

Through the analysis, we can know that in the actual display situation, the effect is still very obvious, and it is in good strength on the whole horizontal axis. In particular, the display strength of sample set *K* in the interval of 2–3 is up to 85%. Therefore, the spatial coordinate system algorithm designed in this paper is very effective. In actual operation, the average display effect can reach 60.4%. In the process of digitization, this paper also analyzes the loss rate of digitization. It can be seen from the data that the loss rate is generally low, but it is worth noting that if the data set is too large, the loss rate will increase. Therefore, the capacity of the data should be reasonably controlled.

5. Conclusions

In the field of cultural heritage protection, the future application of VR technology will be more and more extensive, and the experiencers will have higher requirements for 3D fidelity. Therefore, the related technology research will become more and more urgent. In the process of heritage information collection, statistics, processing, storage, and display, a large number of equipment and a large number of computer software and hardware are needed to assist. It has become an inevitable trend to make rational use of modern scientific and technological means such as digital technology and information technology for development protection. This paper analyzes the advantages of image-based rendering technology in virtual scene construction, as well as the problems that need to be solved based on image-based rendering technology. Construction and manipulation are given in detail. On the basis of analysis and experiment, after calculation, the average spatial data acquisition efficiency can reach 61.8%. In practice, the average display effect can reach 60.4%.

Data Availability

Data are available on request from the corresponding author.

Conflicts of Interest

The authors declare that they have no competing interests.

References

- [1] P. Zheng and L. Huang, "Research on the application of 3D VR technology in the protection and development of ancient villages," *Revista de la Facultad de Ingenieria*, vol. 32, no. 5, pp. 766–774, 2017.
- [2] D. Cao, G. Li, W. Zhu et al., "VR technology applied in digitalization of cultural heritage," *Cluster Computing*, vol. 22, no. 4, pp. 1–12, 2017.
- [3] Z. Liang and R. Shuang, "Research on the value identification and protection of traditional village based on VR technology," *Boletin Tecnico/Technical Bulletin*, vol. 55, no. 4, pp. 592–600, 2017.
- [4] C. Kai-YiL. Ko-Fong et al., "Effects of a ubiquitous guide-learning system on cultural heritage course students'

Retraction

Retracted: Quality Evaluation Method of College Sports Long Jump Training Course Based on Genetic Algorithm

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] B. Han, Z. Wang, and Z. Zhao, "Quality Evaluation Method of College Sports Long Jump Training Course Based on Genetic Algorithm," *Mobile Information Systems*, vol. 2022, Article ID 7905389, 10 pages, 2022.

Research Article

Quality Evaluation Method of College Sports Long Jump Training Course Based on Genetic Algorithm

Bing Han ¹, Zhen Wang ², and Zhilong Zhao ³

¹College of Physical Education, Xi'an University of Architecture and Technology, Xi'an 710055, China

²Department of Physical Education, Xi'an Jiaotong University, Xi'an 710049, China

³Dean's Office, Hebei Sport University, Shijiazhuang 050041, China

Correspondence should be addressed to Zhilong Zhao; zhilongzhao@hepec.edu.cn

Received 7 May 2022; Revised 10 June 2022; Accepted 14 June 2022; Published 24 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Bing Han 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 accuracy of the quality evaluation of college sports long jump training courses, this paper studies the quality evaluation method of college sports long jump training courses based on a genetic algorithm. According to the purpose of college long jump training course evaluation, basic principles of teaching quality evaluation and classroom teaching evaluation standards constructs the establishment process of evaluation index system and calculates the weight of long jump training course quality evaluation index based on AHP method, so as to provide index basis for subsequent quality evaluation; The quality evaluation model of the long jump training course is constructed based on the genetic algorithm. Through cross operation and mutation operation based on adaptive mutation probability, the high accuracy evaluation of college sports long jump training course quality is realized. The experimental results show that the evaluation accuracy of this design method is higher than 97.21%, and the evaluation satisfaction is higher than 97.15%, which significantly improves the accuracy of the university sports long jump training courses and has practical significance in the course evaluation.

1. Introduction

Mastering the laws of motivation and behavior and consciously guiding students' behavior are the main means to regulate the communication between teachers and students and improve the relationship between teachers and students [1–3]. "Behavioral science" believes that human behavior is determined by motivation, and motivation is caused by need. To stimulate people's work motivation, we must deeply understand and study people's needs. Only by constantly meeting people's needs, we can effectively stimulate people's internal motivation and cause people's conscious behavior. This reminds us that in order to have a good long jump training course in colleges and universities, we must master the needs of students and study the laws of motivation and behavior [1, 4, 5]: do not simply cram for the completion of the syllabus and teaching materials, but prepare for lessons and people. Before class, we should not only understand the situation of students' skills and physical fitness but also

understand what students think, like, and expect from the long jump class.

The rapid development of Internet information technology has an important impact on students' growth, learning, and development. Although with the gradual deepening of China's educational reform, physical education teaching has made remarkable progress [6–8]. However, because some teaching ideas can not fully meet the needs of modern physical education, the effect of physical education is poor and even can not meet the actual needs of modern physical education and talent training to some extent. Using big data analysis technology to evaluate physical training courses can not only provide a reference for modern college educators but also have certain guiding significance for the exploration of college physical education curriculum reform and development under the background of the Internet.

Based on modern Internet information technology, college students have been used to using the Internet to deal with affairs in life and study. Therefore, in the context of the

Internet, college educators should deeply realize that the traditional physical education curriculum evaluation methods can no longer meet the needs of modern physical education. Only under the guidance of relevant school physical education administrative regulations, based on the actual characteristics of students, and through the deep integration of the Internet and physical education curriculum, they can gradually explore a teaching evaluation model that can effectively attract students' attention and enhance their learning interest. Under the background of the Internet, with the help of big data technology, we can not only comprehensively analyze and summarize students' learning characteristics, learning interests, and learning needs but also effectively enrich physical education teaching content and provide more high-quality physical education teaching services for college students. Therefore, in the sports long jump training and teaching, physical educators should pay attention to the comprehensive integration of big data analysis technology and physical education curriculum evaluation indicators and then make more reasonable adjustments to the teaching plan, teaching content, and teaching objectives. In this way, we can realize the reform and development of the physical education curriculum and then provide students with more professional, rich, interesting, and practical modern physical education teaching services.

For a long time, most of the traditional teaching quality evaluations is done by five evaluation subjects: teaching experts, school leaders, teachers' peers, and students in the teaching management department of colleges and universities [9]. Through the weighted scoring of the five evaluation values, the teaching quality and teaching level of teachers in a period of time can be obtained according to the weighted result value. Although the traditional model can also evaluate the teaching quality, it is affected by subjectivity, the evaluation result is vague and one-sided, and the result of teaching quality evaluation is easy to be transferred by people's will.

With the development of computer technology and information technology, many scholars directly establish the mathematical model of the teaching evaluation system. Literature [10] puts forward the evaluation method of physical education teaching quality in application-oriented colleges and universities. According to the educational concept and talent training orientation of application-oriented colleges and universities, this paper analyzes the needs of physical quality and basic ability of motor skills, designs the evaluation system of physical education teaching quality through literature review and data analysis, and realizes the evaluation of physical education teaching quality in colleges and universities. Literature [11] takes 10 colleges and universities in Sichuan Province as the survey object, starting from the relevant theories of physical education and management and uses the methods of questionnaire, literature, and mathematical statistics to evaluate the physical education teaching and training activities in colleges and universities. The risk of physical education teaching in colleges and universities is divided into four types (26 items), teacher factors, student factors, environmental factors, and school

management factors. Taking the characteristic root of the factor greater than 1 as the standard, eight factors are extracted in order to find out the main risks. To sum up, the advantages of the above-given method are that various evaluation factors are fully considered and expert experience and knowledge are reflected; the deficiency is that there is randomness and subjectivity in the evaluation process, which fails to take into account the nonlinear relationship between each evaluation index and teaching effect, so that the evaluation results have great subjectivity, resulting in the failure to truly reflect the situation of teaching quality [12–16].

Genetic algorithm is a randomized search heuristic method referring to natural heredity and natural selection in the biological world. This method has the advantages of simple and universal, parallel computing, strong global search ability, and strong robustness. Some scholars use genetic algorithm optimized neural networks to study the evaluation of water quality, soil quality, air quality, and other fields, but it is rarely applied to the field of teaching quality evaluation. This paper combines a genetic algorithm to evaluate the quality of college sports long jump training course, fully overcomes the defects of the above methods, and constructs the establishment process of an evaluation index system according to the basic principles and standards of teaching quality evaluation; the weight of evaluation index of long jump training course quality is obtained based on AHP method; this paper creatively constructs the quality evaluation model of a long jump training course based on genetic algorithm and realizes the quality evaluation of college sports long jump training course through cross operation and mutation operation based on adaptive mutation probability. The experimental results show that the design method in this paper significantly improves the accuracy of the quality evaluation of college sports long jump training courses and is a more effective evaluation method.

2. Evaluation Index System for the Quality of College Sports Long Jump Training Courses

2.1. Evaluation Index of Long Jump Training Course Quality. The physical education curriculum learning evaluation index is not only the standard to measure and evaluate the effect of physical education teaching but also the intuitive presentation of physical education teaching concept [3, 17–21]. It is mainly selected and set from the following angles. One is to measure and evaluate specific sports events, focusing on the students' mastery of skills in relevant sports events, which is mainly related to the content of physical education teaching; second, from the perspective of extracurricular exercise, focus on the evaluation of students' physical exercise habits, mainly related to extracurricular training; the third is to dynamically track the growth of students' physical and mental quality by introducing intelligent technology from the perspective of sustainable growth; fourth, starting from the situation of sports literacy, focus on the evaluation of students' sports character, collective sense of honor, and so on [22–24]. The setting of physical education curriculum learning evaluation indicators should be considered from

the perspectives of theoretical basis, experience reference, basic ideas, and construction strategies.

With the deepening of people's understanding of the value of health promotion of physical education curriculum, the idea of "health first" has widely penetrated into the formulation of physical education curriculum standards and the construction of physical education teaching materials in the new century, which is the physical education curriculum at the social level [25–27]. The physical education courses and big break sports activities set up by various schools at all levels according to the curriculum plan and physical education curriculum standards belong to the physical education courses at the school level, while the physical education courses that physical education teachers really implement and students really experience in the curriculum implementation activities such as physical education teaching and big break sports activities are the physical education courses at the teaching level and experience level [3, 28–31]. School physical education curriculum inherently includes physical education and extracurricular physical activities, including explicit physical education curriculum and invisible physical education curriculum, with the dual character of subject curriculum and activity curriculum. Curriculum theory has been separated from teaching theory. Our physical education curriculum evaluation here must consider the physical education curriculum at the teaching level and experience level. At the same time, we should stand at the height of the physical education curriculum at the school level and systematically evaluate the physical activities in the school, so as to promote the discipline development thought of "health first," and reflect the positive role of physical education curriculum in school talent training. The essence of physical education curriculum refers to a curriculum in which students take the initiative to improve their health quality and sports cultural quality and gradually develop a sports lifestyle in the environment of school education. From the essential meaning of physical education curriculum, physical education curriculum reform should avoid the phenomenon of seeing "things" but not "people" and turn from strictly following the discipline characteristics of physical education to paying close attention to the theme needs of students. Physical education curriculum evaluation should follow the principle of "people-oriented" and build a scientific and reasonable new physical education curriculum quality evaluation system based on students as the main body, physical exercise as the main means, and improving health as the main goal and core [32, 33]. Delphi method is used to establish and revise the curriculum quality evaluation index system. Based on the characteristics of physical education and the guiding ideology of curriculum quality evaluation, the three-level structure is adopted, and the first-level indicators are preliminarily formulated, which should include three parts: curriculum conditions, curriculum implementation, and curriculum effect; secondly, each index will be given a score of 9, 7, 5, and 3, respectively, according to "important," "more important," "general," and "unimportant," and experts are invited to score according to the degree of importance. Statistical calculation shall be carried out after receiving the comments of experts. First, the

concentration (importance) of expert opinions is calculated. According to the statistical results, those whose importance is less than 6 should be classified. The three-level index items shall be screened as necessary, and the index items that can best represent the curriculum quality after repeated deliberation shall be selected, and the weight number shall be reasonably distributed, and finally the index system shall be formed.

The teaching quality evaluation index system designed in this paper should follow the following basic principles: (1) the principle of comprehensiveness. According to the training objectives of college students and from the root of quality education, the construction of the teaching quality evaluation system in this paper should follow the principle of comprehensiveness and investigate the comprehensive situation of teaching quality from multiple angles and levels. The principle of comprehensiveness is helpful to promote the all-round development of teachers' teaching level and the promotion of students' quality education; however, comprehensiveness does not include all relevant influencing factors into the teaching quality evaluation system but scientifically and reasonably screens all evaluation factors to obtain the key influencing factors affecting the evaluation of students' comprehensive quality, that is, the so-called evaluation index. (2) While ensuring the comprehensiveness of teachers' teaching quality evaluation system, the principle of directionality should have a certain directionality, that is, the principle of pertinence. The teaching quality evaluation system will cultivate students into talents with strong comprehensive quality with all-round development of morality, intelligence, physique, and beauty, so as to meet the requirements of the society for college graduates. (3) The principle of incentive and improvement. The principle of objectivity the objectivity of teaching quality evaluation results is the key to teaching quality evaluation. We should truly and comprehensively collect evaluation data, be objective and fair, seek truth from facts, and do not mix personal feelings. (5) Consistency principle. The same standard should be adopted for all the objects participating in the evaluation, and the same number and level of evaluation individuals should be determined for all the evaluation objects. (6) The principle of subjectivity in quality education in colleges and universities, students are the main body of training and development. Only when teachers' teaching behavior and the content of knowledge taught are integrated into students' cognitive structure and ability, can students' comprehensive quality be truly improved. (7) The feasibility principle, the design of evaluation indicators and the selection of methods, the way of collecting information, and the technologies and measures used in information processing should strive to be objective, comprehensive, practical, simple and easy to save human, financial, and material resources.

The research on the content of teaching quality evaluation is reflected in the establishment of a teaching quality evaluation system. Different teaching quality evaluation items are adopted according to the evaluation subject, university type, discipline, and specialty. The following describes the selection of teaching quality evaluation items from two aspects: teachers' quality focuses on their own

professional quality, teaching attitude focuses on teaching preparation and management, and teaching content emphasizes the accuracy, depth, and breadth of the content prepared by teachers, and teaching methods pay attention to the mastery of basic teaching skills and the flexible application of teaching methods, and teaching effect refers to students' knowledge of theoretical knowledge, innovation ability, and problem-solving ability.

Classroom teaching evaluation criteria are formulated according to classroom teaching objectives to check the achievement of classroom teaching objectives. The action essentials of "standing long jump" are an important basis for determining the evaluation criteria: (1) slightly separate your feet, stand naturally, and tilt your upper body slightly forward. Raising both arms back, (2) swinging your arms upward. At the same time, both legs naturally do elastic flexion and extension once; (3) the two arms fall back from the front up and down and swing back, and the two legs naturally flex and stretch again; (4) swinging your arms forward. At the same time, pushing the ground hard with both feet and jump forward and up quickly; (5) when landing, your feet should land first, be light, bend your knees and cushion at the same time, and maintain balance by swinging your arms, be stable.

According to the above-given theory, the establishment process of the index system is shown in Figure 1.

As shown in Figure 1, the design of teaching content, teaching organization form, teaching objective design, and teaching method application are targeted from the perspective of the horizontal and vertical teaching process. The evaluation indexes such as teaching satisfaction are designed from the perspective of teaching effect. From the perspective of teaching evaluation, timely evaluation and application, formative evaluation application, and other content evaluation indicators are designed. Based on the process shown in Figure 1, a comprehensive quality evaluation index system of a long jump training course is established, and the index weight is calculated.

2.2. Weight Calculation of Long Jump Training Course Quality Evaluation Index Based on AHP. First, the evaluation index content system will be established initially to establish the hierarchical index system according to the target layer, criterion layer, and subcriterion layer. The evaluation index system obtained is shown in Table 1.

Next, the indexes of the first level index layer and the second level index layer are compared, respectively. This paper uses the teaching competent department and supervision experts familiar with the evaluation of classroom teaching quality to determine the score and constructs the judgment matrix A . At the same time, in order to avoid the disadvantages of evaluation distortion caused by too large or too small weight difference among subjects, compared with the 9-point scale method and the 1.354 scale method, the golden section 0.618 is selected as the analytic hierarchy process of scale to judge the assignment of elements in the matrix; then, using the MATLAB software programming, the maximum characteristic root of each judgment

matrix km ax and the corresponding characteristic vector of KM ax are obtained, respectively, and the consistency test is completed.

3. Quality Evaluation Method of College Sports Long Jump Training Course Based on Genetic Algorithm

3.1. Long Jump Training Course Quality Evaluation Model Based on Genetic Algorithm. In the 1970s, a genetic algorithm was proposed. In the 1980s, the genetic algorithm became a very hot research topic because of its success in economic prediction and other application fields. A genetic algorithm is an algorithm that refers to and simulates biological genetic mechanisms and natural selection. Through "survival of the fittest," the solution of the problem can evolve in the competition, so as to obtain a satisfactory solution of the problem. The basic idea of a genetic algorithm is to simulate the evolution process of the population. This process is to exchange and recombine the organized random information of individuals. In the string structure of the previous generation, select the bits and segments with good adaptability to recombine, so as to generate a new generation of population, the population is constantly updated, and the excellence of the population is continuously enhanced to approach the global optimal solution. At present, genetic algorithm has developed into a relatively mature comprehensive algorithm, which is applied in function optimization, combinatorial optimization, automatic control, production scheduling, image processing, machine learning, and so on.

Compared with other modern optimization algorithms, the genetic algorithm has the following characteristics: (1) the direct object is not the set of parameter variables, but the intermediate medium, which is a form of a coding string of the set of parameter variables; (2) using the fitness function value, there is no need to use other additional information; (3) probability transfer rules are adopted instead of other uncertain and fuzzy rules. The advantages of genetic algorithm are as follows: (1) it has the ability of multibranch global search and is not easy to fall into local optimization; (2) fault tolerance. In the initial population of the genetic algorithm, there are some individuals who deviate greatly from the optimal solution. These individuals can be effectively eliminated after a series of operations; (3) it can carry out parallel computing and speed up the speed of obtaining the global optimal solution; (4) robustness. In noisy space, the global optimal solution can still be found with great probability and can improve the accuracy of long jump training course quality evaluation.

In the traditional genetic algorithm, the probability of mutation operation is determined according to the empirical value. When the model based on the algorithm starts running until the actual problem is solved successfully, the mutation probability is fixed. However, in the evolution of nature, the mutation probability is not fixed. Having different mutation probability in different environments is more conducive to the development of the population. Under the evolutionary rule of "natural selection and

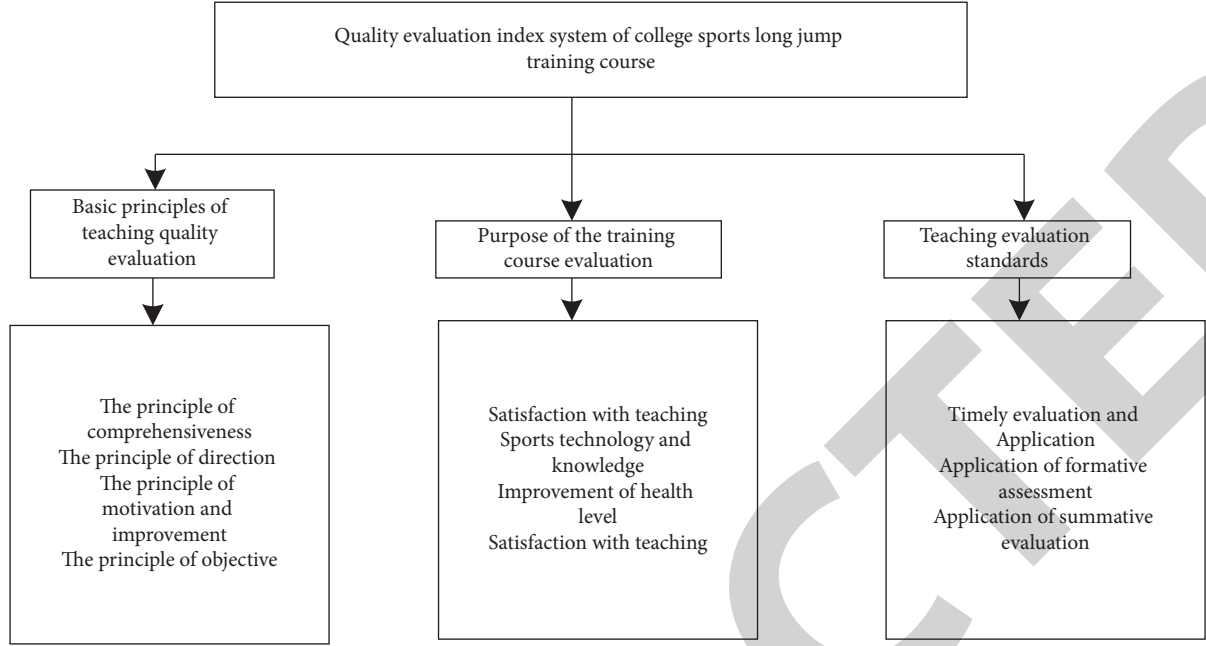


FIGURE 1: The construction process of the index system.

TABLE 1: Evaluation index system.

| Level 1 indicators | Symbol | Secondary indicators | Symbol |
|--------------------------------|--------|---------------------------------------|--------|
| Training preparation effect | A1 | Teaching plan design level | B1 |
| | | Training equipment preparation status | B2 |
| | | Training method | B3 |
| | | Training step design | B4 |
| Training practice effect | A2 | Long jump training environment | B5 |
| | | Training schedule | B6 |
| | | Training process safety degree | B7 |
| | | Training for guidance accuracy | B8 |
| Training and teaching guidance | A3 | Training guidelines | B9 |
| | | Training guidance attitude | B10 |
| | | Training overall planning level | B11 |
| | | Training emergency ability | B12 |
| Training teaching effect | A4 | Student long jump results | B13 |
| | | Student long jump ability | B14 |
| | | Student's physical fitness level | B15 |
| | | Student's training knowledge | B16 |

survival of the fittest,” the population can more adapt to the natural environment. This paper proposes an adaptive mutation genetic algorithm, which improves the mutation operation in the genetic algorithm. The mutation operation helps to improve the diversity of the population of the genetic algorithm. At present, the mutation probability is obtained through continuous experiments. The adaptability of every life in nature changes dynamically. In the process of finding the global optimal solution by genetic algorithm, the adaptive mutation probability should be adopted. When the population fitness value is poor, the mutation probability should be increased to improve the diversity of the population and increase the number of excellent individuals. When the fitness value is better, that is, when it is close to the global optimal solution, the mutation probability should be reduced. The

calculation of adaptive mutation probability P in this paper is as follows:

$$P = \frac{(P_1 + P_2)}{2} = \frac{(P_0 - (P_0 - P_{\min})) \cdot m}{M}. \quad (1)$$

Here, M represents the maximum evolutionary algebra, m represents the current evolutionary algebra, P_1 is inversely proportional to the evolutionary algebra, P_2 is inversely proportional to the mean fitness value, P_0 is the assumed initial variation probability, and P_{\min} is the minimum of the value range of variation probabilities.

In the process of solving practical problems, the genetic algorithm does not directly search for the feasible solution of mutation probability, but first encodes the individual feasible solution. The coding method greatly affects the

efficiency of the genetic algorithm in searching for the global optimal solution, so it determines that the mutation probability needs to be increased. The main coding methods of the genetic algorithm include binary coding, sequence coding, real number coding, tree coding, out of order coding, large character set coding, and so on. For the more complex solution space, the real number coding method can do without decoding. Therefore, this paper uses the real number coding method to encode the feasible solution.

The determination of the initial population is the set of initial solutions. The larger the number of individuals of the initial population, the stronger the diversity of the initial population, and the greater the probability of finding the global optimal solution. However, if the initial population size is too large, it will directly lead to more calculation times of fitness function, resulting in the reduction of solution efficiency. Therefore, the initial population size cannot be too large or too small. In the application of practical problems, the scale range of the initial population is [20100]. Through continuous experiments, it is concluded that when the initial population number is 20, the error is the smallest, which is 0.2236, and the convergence time is the shortest. In this paper, the initial population is set to 20.

In fitness calculation, the search goal of the genetic algorithm is to obtain the network weight and threshold that minimizes the sum of squares of network errors in all evolutionary generations, while the genetic algorithm evolves in the direction of increasing the value of fitness function. Therefore, the fitness function is set as the reciprocal of each individual learning error. The learning error is shown in the following formula:

$$E = \frac{\sum_{k=1}^p \sum_{j=1}^l (y_j^k - o_j^k)^2}{2} \quad (2)$$

Here, E is the learning error, p is the number of training samples, l is the number of output nodes, and $y_j^k - o_j^k$ is the error of the k sample relative to the j output node.

3.1.1. Cross Operation. The cross operation in genetic operation is to exchange some genes to form new individuals, so as to achieve the purpose of population renewal. In the population with a high crossover probability, the faster the new structure will be introduced. The loss speed of the obtained excellent gene structure is relatively high, and too low crossover probability will lead to a search block. Generally, the range of crossover probability is [0.6, 1.0]. There are also many ways of crossover operation, including single point crossover, two-point crossover, arithmetic crossover, uniform crossover, heuristic crossover, and so on. Uniform crossover can speed up the discovery of new better modes at the beginning of the iteration, prevent convergence to local extreme points when convergence tends, and has better recombination ability than a classical crossover, which can speed up the convergence speed of the genetic algorithm. Therefore, this paper adopts uniform crossover operation in the genetic algorithm.

3.1.2. Mutation Operation Based on Adaptive Mutation Probability. Mutation operation is when some individual

genes in the population mutate with a certain probability. The model adopts the mutation operation of adaptive mutation probability. Although there will be bad individual shape to a certain extent, in general, through the genetic operation method of mutation, it will retain some favorable mutation, enhance the diversity of the population of genetic algorithm, make it jump out of the local optimization in time, search the global optimal solution, and avoid the premature phenomenon.

The optimal solution searched by the genetic algorithm is input into the BP neural network as the initial weight and threshold of the network. The data flow direction of the model is shown in Figure 2.

- (1) The input of the AGA-BP algorithm model starts from the BP neural network part. According to the data collected by the questionnaire, the learning samples are determined, so as to determine the topology of the neural network, that is, the number of network layers and neurons and then obtain the initial population of the adaptive mutation genetic algorithm.
- (2) Processing, the data information processing part starts from the genetic algorithm part of adaptive mutation and determines the solution that meets the stop condition, that is, the optimal weight and threshold, through coding, fitness calculation, genetic operation, and other steps. After obtaining the initial weight and threshold, BP neural network can reduce the time to find the optimal weight and threshold, so as to speed up the convergence speed of the network.
- (3) When the learning error or iteration times of the sample meet the requirements, a better AGA-BP algorithm model is obtained.

In this paper, a teaching quality evaluation model is established by combining a genetic algorithm and a neural network. The adaptive mutation probability is adopted in the genetic operation process, which not only improves the convergence speed of the neural network but also reduces the complexity of the training process. The model not only gives play to the advantages of improved genetic algorithm global search and BP neural network in nonlinear mapping but also reduces the influence of nonobjective factors. The main modeling steps of the teaching quality evaluation model are as follows.

- (1) By analyzing the existing problems of teaching quality evaluation, we can improve it and establish a more perfect and suitable index system.
- (2) Sample data of teaching quality evaluation are collected, evaluation indicators according to teachers' teaching characteristics are selected, and the collected teaching quality evaluation data are divided into training samples and test samples.
- (3) The parameters of the BP neural network algorithm are determined, including learning rate, number of hidden layer neuron nodes, maximum iteration times, minimum error accuracy, transfer function, and training times.
- (4) By inputting samples into the evaluation model, iterative training is carried out until the

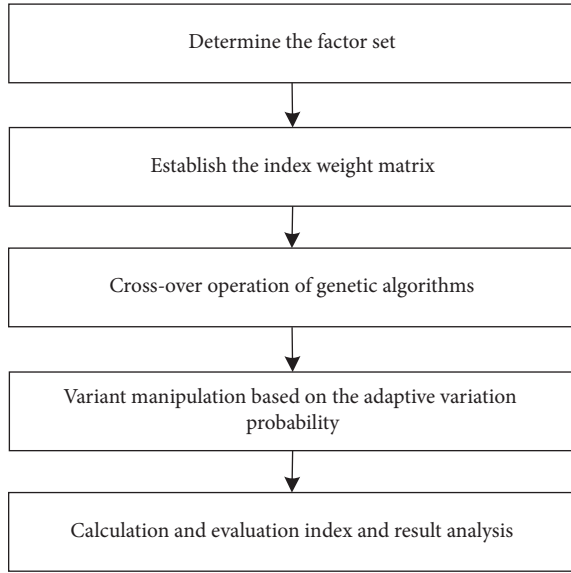


FIGURE 2: Establishment process of long jump training course quality evaluation model.

trigger algorithm stops. (5) The test samples of teaching quality evaluation are input to test whether the training effect of the BP neural network model optimized by an improved genetic algorithm meets the requirements. The training data is used to train the network. The sum of the absolute value of the error between the actual output and the expected output is taken as the individual fitness value. According to the inverse relationship of fitness value and learning error, the calculation formula of obtaining individual fitness value F is as follows:

$$F = \frac{1}{E}. \quad (3)$$

If the individual fitness value meets the stop requirement, proceed to the next step; otherwise, return to the previous step and train the network again, that is, return to Step (3). (6) The samples are input into the teaching quality evaluation model to obtain the teaching quality evaluation results. The sum of the training errors of the BP neural network is used as the fitness function.

3.2. Realization of Quality Evaluation of College Sports Long Jump Training Course. Based on the connotation and evaluation method of the evaluation elements in the quality evaluation table of college sports long jump training course, the evaluation elements are divided into four levels: excellent a (100-90), good B (90-75), qualified C (75-60), and unqualified D (60-0). The main steps of the evaluation are as follows:

Step 1: a curriculum evaluation team is composed of experts, teachers, and students.

Step 2: the “comprehensive scoring table” is submitted including scoring factors, rating levels, and weights of various indicators to the corresponding members of the curriculum evaluation team, and the “actual scoring registration form” is listed after examining,

investigating, and observing the physical education curriculum according to the indicators in the table. That is, the specific number of “excellent,” “good,” “qualified,” and “unqualified” of each three-level index is counted.

Step 3: the comprehensive score of each three-level index is calculated in combination with the actual weight, then the score of each evaluation unit is calculated, and finally the total score s is calculated. So as to evaluate the quality of the implementation link and the educational effect of the physical education curriculum. The evaluation results are evaluated according to four levels: excellent, good, qualified, and unqualified. Excellent: $90 \leq s < 100$; All core indicators are a, and there can be no levels C and D in all indicators; Good: $75 \leq s < 90$; there shall be no less than 4 core indicators with a, and there shall be no level D in all indicators; Acceptable: $60 \leq s < 75$; there can be no level D in the core indicators; among other indicators, there is no more than 1 level D; Unqualified: $s < 60$ or grade D in the core index.

To sum up, the research on the quality evaluation of college physical education curriculum is to objectively and accurately understand the significance and essence of the college Physical Education Curriculum in the process of cultivating professional talents. The construction of the physical education curriculum quality evaluation index system is not only an exploration of physical education curriculum quality evaluation but also can promote the quality education of physical education curriculum, which is of great significance to improve the function of physical education.

4. Experimental Test

In order to test the performance of the design method in this paper, the simulation experiment is carried out on the MATLAB platform. The sample data comes from the evaluation results of physical training classroom teaching of 75 physical education teachers in a university. According to the evaluation index system selected above, the weight of the evaluation index is obtained by questionnaire.

The questionnaire designed in this paper adopts a comprehensive form, including multiple-choice questions and open-ended questions. Because the questionnaire in this paper is a quantitative questionnaire, it is also necessary to score within the scope of the options after selecting the appropriate options. The second part is an open-ended question. From the perspective of data analysis, the content of this part is not included in the total score of the questionnaire. In the teaching quality evaluation questionnaire, the answer options of some questions involve very consistent (81-100), consistent (61-80), generally consistent (41-60), inconsistent (21-40), and very inconsistent (0-20). The subjects of the five answers questionnaire are undergraduates in a university. Taking the class as the unit, they entrust the monitor to distribute them during the recess. 1100 questionnaires were distributed, 1050 were recovered, and 1000 were effective after screening. That

TABLE 2: Weight value of the evaluation index.

| Level 1 indicators | Weight | Secondary indicators | Weight |
|--------------------|--------|----------------------|--------|
| A1 | 0.7536 | B1 | 0.2118 |
| | | B2 | 0.4523 |
| | | B3 | 0.7341 |
| | | B4 | 0.8572 |
| A2 | 0.8239 | B5 | 0.7235 |
| | | B6 | 0.8238 |
| | | B7 | 0.8234 |
| | | B8 | 0.7535 |
| A3 | 0.3181 | B9 | 0.5317 |
| | | B10 | 0.7836 |
| | | B11 | 0.7482 |
| | | B12 | 0.7563 |
| A4 | 0.6297 | B13 | 0.7817 |
| | | B14 | 0.7920 |
| | | B15 | 0.8416 |
| | | B16 | 0.8437 |

TABLE 3: Evaluation results.

| Serial number | The method of this paper | | literature [10] method | | literature [11] method | |
|---------------|--------------------------|------------------------------|------------------------|------------------------------|------------------------|------------------------------|
| | Accuracy of evaluation | Satisfaction with evaluation | Accuracy of evaluation | Satisfaction with evaluation | Accuracy of evaluation | Satisfaction with evaluation |
| 1 | 97.78 | 98.38 | 92.17 | 93.41 | 94.78 | 91.89 |
| 2 | 99.01 | 97.69 | 93.36 | 91.88 | 93.01 | 93.36 |
| 3 | 98.41 | 98.88 | 93.62 | 90.89 | 92.41 | 92.45 |
| 4 | 98.14 | 97.32 | 94.36 | 91.14 | 93.14 | 93.37 |
| 5 | 99.66 | 99.17 | 91.01 | 92.17 | 93.66 | 91.45 |
| 6 | 97.21 | 98.45 | 92.42 | 93.45 | 91.21 | 92.01 |
| 7 | 97.45 | 97.15 | 91.63 | 92.22 | 92.45 | 92.33 |

is, the effective data are 1000 groups. In order to ensure the high reliability and effectiveness of the teaching evaluation indicators, 100 online questionnaires are distributed for testing, and the reliability and validity of the test results are tested to test whether each index in the teaching quality evaluation index system has reliability and effectiveness at the same time. If the questionnaire meets the two standards, 1000 questionnaires will be distributed. According to the results of the questionnaire, the secondary and tertiary indicators are weighted, and the weight coefficient table is prepared, as shown in Table 2.

According to the weight results in Table 2, this paper uses this method to evaluate the quality of college sports long jump training courses and analyzes the test results.

In order to make the genetic algorithm obtain a better initial population size, according to the range of the initial population size, this paper sets the initial population size to 20, 30, and 40, respectively and carries out experiments, respectively. When the initial population size is 20, the convergence time is the shortest, 126.37 and the error is the smallest, 0.2236. Therefore, the initial population size is 20. The crossover probability is set to 0.66. For the more complex solution space, the real number coding method can be used to code the feasible solution without decoding. Therefore, this paper uses this coding method to directly take the optimal solution as the initial weight and threshold of the BP neural network. The coding string is composed of four

parts: the connection weight from the input layer to the hidden layer, the connection weight from the hidden layer to the output layer, the threshold of the hidden layer, and the threshold of the output layer. The encoding length is 101.

In order to improve the accuracy, the number of layers can be increased appropriately, but with the increase of the number of layers, the network will become complex. Increasing the number of neurons in the hidden layer can also improve the error accuracy. From the perspective of structure realization, the way of adding hidden layer nodes is simpler than adding more hidden layers, and its training effect is easier to observe and adjust. Therefore, this paper uses the method of adjusting the number of hidden layer nodes to change the accuracy and efficiency of the network and takes the course evaluation system of theory course as an example. In this paper, the course quality evaluation model sets the neural network as a single hidden layer, that is, a three-layer neural network. After repeated experiments, the selected BP neural network topology and parameters are as follows:

- (1) The number of secondary indicators in the teaching quality evaluation system is 16, so the number of neurons in the input layer is set to 16.
- (2) According to the empirical formula, when the initial number of hidden layer nodes is 6, multiple network structures are set, and the number of hidden layer

nodes of each network increases by 1. When the number of hidden layer nodes is 6, the error is the smallest. Therefore, the number of hidden layer nodes of the BP neural network is set to 6.

- (3) Determination of the number of neurons in the output layer: the output target is the result of course quality evaluation, so the node of the output layer is 12.

Using the optimal evaluation model designed in this paper and the literature [10] method and literature [11] method evaluated the quality of the sports long jump training course in a university that put the questionnaire and divides the students who choose long jump courses into 7 groups for evaluation. The accuracy and satisfaction results of the evaluation are shown in Table 3.

According to the evaluation result data in Table 3, the quality evaluation method of college sports long jump training course based on the genetic algorithm designed in this paper has high evaluation accuracy and satisfaction. The evaluation accuracy of this design method is higher than 97.21%, and the evaluation satisfaction is higher than 97.15%. The evaluation accuracy of literature [10] method is lower than 94.36%, and the evaluation satisfaction is lower than 93.45%. The evaluation accuracy of literature [11] method is lower than 94.78%, and the evaluation satisfaction is lower than 93.37%. The reason for the advantage is the evaluation index weight of long jump training courses based on the AHP method, which provides an accurate and comprehensive basis for subsequent quality evaluation, quality evaluation model of long jump training courses based on a genetic algorithm, and high accuracy evaluation of college sports long jump training courses through cross operation and variation operation based on adaptive variation probability.

5. Conclusion

In view of the shortcomings of the existing quality evaluation methods of college sports long jump training courses, such as poor learning generalization ability and large prediction error, combined with the screening of important evaluation indexes by domestic scholars, this paper puts forward the quality evaluation method of college sports long jump training courses based on a genetic algorithm. According to the purpose, basic principles and evaluation criteria of college long jump training course evaluation, construct the establishment process of evaluation index system, calculate the weight of long jump training course quality evaluation index based on the AHP method, construct the quality evaluation model based on the genetic algorithm, and realize the high accuracy evaluation of college sports long jump training course quality through cross operation and variation operation. The test results show that this method greatly improves the evaluation accuracy and evaluation satisfaction and has a good application prospect in teaching management. However, there are also some deficiencies in the method of this paper, and the classification of course types is not rich enough. The future research can determine the

content of the corresponding teaching quality evaluation system according to expert interviews and other ways. In addition, for the quality evaluation method of sports long jump training courses in universities, an evaluation system or software based on this method can be developed for real-time evaluation of the teaching quality of physical education teachers, which is more efficient and reliable.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest..

References

- [1] M. Kara and S. Kunt, "An examination of Sarikami destination competitiveness from the luge athletes' perspective: the relationship between tourism experience and perceived destination competitiveness," *Anais Brasileiros De Estudos Turísticos-ABET*, vol. 10, no. 1, pp. 1–10, 2021.
- [2] J. T. Sun and Z. Ping, "On the teaching evaluation system in heilongjiang province," *Sports Science and Technology Document*, vol. 14, no. 9, pp. 15–18, 2020.
- [3] Y. Karaca and B. Filiz, "Physical education and sports course value orientations of secondary school students," *Kuramsal Eğitimbilim*, vol. 13, no. 4, pp. 716–730, 2020.
- [4] D. Aras, S. Yiğit, S. Kayam, E. Arslan, and F. Akça, "Bilişsel yorgunluğun Egzersiz ve spor performansına Etkileri," *Ankara Üniversitesi Beden Eğitimi ve Spor Yüksekokulu SPORMETRE Beden Eğitimi ve Spor Bilimleri Dergisi*, vol. 18, no. 1, pp. 1–32, 2020.
- [5] H. Lper and E. Kiraz, "Türke renen yabancı renciler asndan gazeteleri okuyabilmek iin gereksinim duyulan szcük sayşnn belirlenmesi," *Erzincan niversitesi Eitim Fakültesi Dergisi*, vol. 22, no. 3, pp. 708–722, 2020.
- [6] A. Li, C. Masouros, A. L. Swindlehurst, and W. Yu, "1-Bit massive MIMO transmission: embracing interference with symbol-level precoding," *IEEE Communications Magazine*, vol. 59, no. 5, pp. 121–127, 2021.
- [7] K. Wang, H. Wang, and S. Li, "Renewable quantile regression for streaming datasets," *Knowledge-Based Systems*, vol. 235, Article ID 107675, 2022.
- [8] H. Liang, "Role of artificial intelligence algorithm for taekwondo teaching effect evaluation model," *Journal of Intelligent and Fuzzy Systems*, vol. 40, no. 2, pp. 3239–3250, 2020.
- [9] Y. Chen, "Evaluation of teaching effect of internet of things education platform based on long-term and short-term memory network," *International Journal of Continuing Engineering Education and Life Long Learning*, vol. 31, no. 1, p. 1, 2021.
- [10] Y. Wang, "Design of physical education teaching quality evaluation system in application-oriented colleges and universities," *Contemporary Sports Technology*, vol. 11, no. 30, p. 8, 2021.
- [11] N. Xiao, G. H. Zhu, N. Xiao, and G. H. Zhu, "Risk assessment and planning of physical education teaching activities in colleges and universities," *Sport Science And Technology*, vol. 2014, no. 2, pp. 141–143, 2021.

Retraction

Retracted: Library Document Resource Construction and Data Sharing Based on Semantic Web Technology

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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] X. Fan, "Library Document Resource Construction and Data Sharing Based on Semantic Web Technology," *Mobile Information Systems*, vol. 2022, Article ID 2168655, 11 pages, 2022.

Research Article

Library Document Resource Construction and Data Sharing Based on Semantic Web Technology

Xinyuan Fan 

Library, Sichuan University, Chengdu, Sichuan 610064, China

Correspondence should be addressed to Xinyuan Fan; xy-fan@scu.edu.cn

Received 10 May 2022; Revised 3 June 2022; Accepted 8 June 2022; Published 23 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Xinyuan Fan. 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 of the reform and development of higher education, many colleges and universities have taken the merger as an opportunity to promote the leap-forward development of their schools. Some colleges and universities that have not merged have also taken the newly-built campus as a new growth point to promote the rapid development of their schools. The library's collection structure reflects a library's document support ability, and the formation of the collection structure depends on the accumulation of document resources. Based on semantic web technology, this paper studies the construction of library literature resources. Among the institutions that choose to give priority to the development of library literature resources in the development strategy of main literature resources, the proportion of long-term preservation practice has reached 65.23%, compared with 57.42% of all other institutions. Due to the small number of samples, we cannot make a simple statistical inference, but it may reflect from the other side that the institutions that pay attention to digital resources are slightly more active in implementing preservation activities than other institutions. Based on the semantic web technology, the integrity and continuity of important documents and characteristic resources were kept and we paid attention to the collection of publications and academic documents related to our school. Under the double restriction of document resources guarantee, the acquisition behavior of guarantee systems at all levels will gradually strengthen self-control, actively establish the concept of coordination and sharing, and gradually move from randomness to standardization.

1. Introduction

With the deepening of the reform and development of higher education, many institutions of higher learning have taken the merger as an opportunity to promote the leap-forward development of their schools. Some institutions of higher learning that have not merged have also taken the newly-built campus as a new growth point to promote the rapid development of their schools. Literature resource construction is the foundation of all the library services and one of the important guarantees for school discipline construction. The library's collection structure reflects a library's literature support ability, and the formation of the collection structure depends on the accumulation of literature resource construction [1, 2]. The library literature resources of the whole school should be effectively integrated

and rationally distributed, and the characteristics and advantages of the collections should be reorganized to form a library literature resource guarantee system with high integration, reasonable structure, complete system, and scientific layout, which is suitable for the leap-forward development of multi-campus universities [3]. The library is the literature information center of the school, an academic institution serving teaching and scientific research, and an important base for school informatization and social informatization. The work of university library is an important part of the school teaching and scientific research. The construction and development of university library should be adapted to the construction and development of the university, and its level is an important symbol of the overall level of the university. The library collection construction and the literature guarantee system are the keys to

do a good job in the allocation of library literature resources for knowledge innovation and are also the needs of library survival and development [4, 5].

With the continuous development of semantic web technology, ontology-based semantic technology and knowledge technology have gradually become the focus and hotspot in the research field of digital library technology and have also become the necessary means to solve how to provide deep-seated knowledge services in the era of network information explosion [6]. The basic idea of semantic web technology is to try to add a layer of semantic description to semantic web resources, which not only facilitates people's use and processing, but also enables computers to "understand" the meaning of web resources to a certain extent, so as to help automate information sharing and reuse and enable the network to provide dynamic, personalized, and active services. Semantic portal reveals the deep-seated relationship between the information contents through ontology and realizes the semantic retrieval and browsing of information through relevant semantic technology standards [7, 8]. Traditional portal is a labor-intensive process when building rich structured hypertext, while semantic portal hopes to establish a highly interconnected content collection through automatic or semi-automatic tool package [9, 10]. Ontology is an effective means to represent domain conceptual model and structured domain knowledge proposed in the context of semantic web technology. Specifically, ontology is a conceptual model that describes concepts and the relationship between concepts and describes the semantics of concepts through the relationship between concepts [11, 12]. Ontology is a collection of common knowledge in related fields, which determines the commonly recognized terms in the field, determines the relationship between these knowledge and terms from multiple dimensions, and provides common understanding and reasoning of knowledge in the field.

The application of semantic web technology in library literature resources construction is mainly embodied in three aspects: semantic description standard, ontology construction, and the generation of related data. Accurate classification of data information, semantic relations, and domain ontology construction are the keys to the quality of semantic web. University libraries must implement the national education policy, fulfill the educational function and information service function and serve for cultivating talents with all-round development in morality, intelligence, physique and aesthetics, developing educational, scientific, and cultural undertakings, and building socialist material and spiritual civilization. By introducing knowledge evaluation, the library can filter and sort the high-quality resources that users need and push them to users, so that users can obtain better services [13]. Based on the semantic web technology, the integrity and continuity of important documents and characteristic resources were kept and we paid attention to the collection of publications and academic documents related to our school. University libraries should organize collections scientifically and reasonably, which is not only conducive to the management and protection of literature information, but also conducive to the full use of

literature information [14]. In the knowledge innovation system of semantic web technology, database construction also belongs to a way of knowledge organization and knowledge dissemination. As an important information resource in the network environment, database is naturally an important index to measure the network status of libraries. The foreign dialog database, the full-text database of Chinese academic journals published by Tsinghua University, China, etc., all occupy the commanding heights of database information products, and their contribution to the development of social information resources and the commercial value they bring are limitless.

The innovations in this paper are as follows:

- (1) This paper constructs the construction model of semantic web technology. The data representation method using semantic web technology to construct model deepens the depth of data integration and widens its application to a greater extent. The theories and the methods of semantic web technology also provide digital libraries with theories and technologies beyond traditional library services.
- (2) The construction of the school literature resources is discussed and analyzed. This paper mainly discusses the construction of document resources in the micro sense, that is, the collection, organization, management, and storage of documents by various document information institutions, which is what we usually call collection construction. Book collection construction is a market behavior of interview decision-making on the basis of understanding the demand. It must deeply understand the demand. Under the dual constraints of benefit evaluation and supervision and document resource guarantee, the interview behavior of security systems at all levels will gradually strengthen self-control, actively establish the concept of coordination and sharing, and gradually move from randomness to standardization.

The overall structure of this paper consists of five parts.

The first chapter introduces the background and significance of library literature resources construction. The second chapter mainly describes the research status of library literature resources construction at home and abroad. The third chapter discusses the realization of semantic web technology in the construction of library literature resources. The fourth chapter makes an experiment on literature construction and analyzes the results. The fifth chapter is a summary of the full text.

2. Research Status of Library Literature Resources Construction at Home and Abroad

Lee and Deborah put forward that in order to build a collection system with its own distinctive features and resources to meet the needs of the university, university libraries must fully study the discipline construction and development of the university [15]. Asemi et al. put forward

the idea of overall development and co-construction and sharing, and gradually built a literature resource system and a modern service system with optimized structure and reasonable layout in the university libraries throughout the province [16]. Kosenko et al. put forward that the process of book collection construction is an information screening process around the needs and meeting the needs, and the screening around information needs is the development process of social information resources [17]. Streimikiene et al. showed that the countermeasures of literature resources construction should first study and analyze the key disciplines of the university where they are located, and it is the fundamental purpose of library literature resources construction to serve the key disciplines and ensure their construction needs [18]. Beyene puts forward that the network information resources in the actual collection cannot be completely digitized, nor can they completely cover the printed literature; the difference in the utilization between the digital information and the printed information carriers and modes of communication determines the significance of the existence of real collections [19]. Joyce puts forward higher requirements for the library's document guarantee function. It is more urgent to establish a document resource guarantee system for knowledge innovation. Its collection construction goal should be: to establish realistic collection and virtual collection [20]. Smith and Van Aken proposed that the continuous development of school discipline construction puts forward higher requirements for purchasers. High quality and compound are the requirements of the new situation for purchasers. Therefore, purchasers must adapt to the requirements of the new situation, constantly increase knowledge reserves, broaden knowledge, and adhere to increasing their comprehensive knowledge level [21]. Castelnovo and Lim put forward that the co-construction and sharing of document resources of university libraries in Northwest China is under the condition that the economy and society of Northwest China seriously lags behind that of eastern China. Lubis et al. put forward the concept of "collaborative development of Regional University Libraries" in the process of getting rid of the survival dilemma and seeking the goal of their own growth and development [22]. Lubis et al. proposed that the document resources of university libraries should be jointly constructed and shared, requiring participating libraries to share their collections within their members, which makes the original readership expand rapidly. This sharing objectively breaks the traditional idea of "collection," the utilization rate of document resources is greatly improved, and the "emphasis on collection and light use" is transformed into "emphasis on collection and reuse," so as to achieve a double breakthrough in theory and practice [23]. Garcia Lillo et al. proposed to formulate a reasonable collection evaluation system index, which should have a practical basis for the purpose, principle, standard, and method of collection evaluation. Through the effective evaluation of reader satisfaction, book borrowing, and the coverage of relevant professional documents, it provides strong support for the construction of literature resources for discipline construction [24].

In view of the former's research on the construction of library literature resources, this paper studies the construction of library literature resources based on semantic web technology, and through the work of subject librarians, we can better improve the literature information demand of the subject construction. Through the division of labor and cooperation of all parties, keep up with the pace of discipline development, understand the trend of discipline development, improve the level of literature resources construction, build a reasonable collection structure, and better guarantee the construction and development of key disciplines. In the semantic web technology system, according to the literature utilization of different libraries, the funding for different libraries is decided. In theory, the guarantee and the utilization ratio are inversely proportional. The higher the guarantee rate, the lower the utilization ratio. A common view of semantic web is that it is impossible to semantically code billions of contents, which is not a small problem. If the function of semantic web depends on manual coding of all the past, present, and future data, it will be doomed to failure. Libraries in institution of higher learning should change the invariable strategy mode in the past. Based on the semantic web technology, the macro strategy should be consistent with the discipline development of institution of higher learning, but the micro strategy should form a dynamic balance according to the needs. Determining the allocation of literature resources according to the utilization of literature is conducive to the close combination of collection construction and demand, avoiding the waste of literature resources, and stimulating the strengthening of library service for readers.

3. Implementation of Semantic Web Technology in the Construction of Library Document Resources

3.1. Concept and Model of Semantic Web Technology. In the process of semantic retrieval, in order to achieve high reasoning and retrieval efficiency, a good query object is very necessary, that is, a clear semantic description of resources can improve the efficiency of retrieval. From this perspective, semantic description is the basis of semantic retrieval, and good retrieval is based on good semantic description. This is one of the main reasons why this paper focuses on semantic description. The "semantics" referred to by semantic web technology is "machine processability," rather than natural language semantics and human reasoning. For data, semantics expresses what machines can do with these data [25]. The goal of semantics is to make the information understood by the computer. Meet the requirements of "effective access and retrieval of heterogeneous and distributed information on intelligent." The main service objects of the university library are teachers and students. They locate users through user login information, establish user interest model through user search information and user's department, and locate the database of excellent students in the relevant fields or disciplines or teachers with outstanding scientific research achievements, so as to realize personalized

recommendation to users. The personalized recommendation process of the university library based on semantic web technology is shown in Figure 1.

The construction of literature and information resources is one of the important guarantees of discipline construction. The construction of literature and information resources facing the discipline direction is the most basic element of the university library and the basis and guarantee of serving the discipline construction. The development of discipline construction in an institution of higher learning is inseparable from the support of library literature and information resources. Without the support of literature and information resources, it is impossible to build a high-level discipline [26]. The data representation method using semantic web technology deepens the depth of data integration and widens its application to a great extent. The theories and methods of semantic web technology also provide digital libraries with theories and technologies beyond traditional library services. Semantic web technology has four functional structures, which are basic function, grammatical function, data expression function, and formal function. The construction model of the semantic web technology is shown in Figure 2.

The semantic web technology construction model diagram is mainly divided into four layers, the details of which are as follows.

3.1.1. Basic Functions. It contains the universal code used to eliminate the limitation of past coding methods and the string used to identify network data: URI. Among them, universal code enables computers to complete the conversion and processing of data resources between different languages and platforms.

3.1.2. Grammatical Function. It covers three parts: extensible markup language, network simulator, and extensible markup language mode. Among them, extensible markup language has the characteristics of marking electronic documents and structuring them. Network simulator is a simulator that operates through discrete events. The last extensible markup language pattern is used to define the legal group of XML documents.

3.1.3. Data Expression Function. It has two parts: RDF and RDFS. Because XML is not suitable for the explicit expression of the meaning of a statement, a new function is needed to operate it. With the emergence of RDF, the expression process of statements has become standardized. RDFS is used to define words used in the process of statement expression, so that computers can understand the meaning of the data.

3.1.4. Formal Function. This is the core function of semantic web technology. Based on the data expression function, it deeply describes the relationship between ontology and them.

The basic assumption of semantic relevance algorithm is that when two words are connected by a short path in

WordNet synonym set, they have relatively large semantic relevance, and the semantic similarity is directly proportional to the semantic relevance

$$Rel_{HS}(W_1, W_2) = C - len - K \times d, \quad (1)$$

where: C and k are two constant parameters, d represents the number of turns in synset, and $len(W_1, W_2)$ is the path length.

Semantic similarity algorithm: when the path length is the same, the closer to the tree root, the smaller the semantic similarity. Therefore, the restriction condition of depth is introduced.

$$Sim_{LC}(W_1, W_2) = \log \frac{len(W_1, W_2)}{2Depth}, \quad (2)$$

where Depth is the depth of words in the semantic tree of WordNet.

Resnik semantic similarity algorithm, the basic assumption is: the semantic similarity of two concepts is determined by the part of concepts they share.

$$Sim_R(W_1, W_2) = -\log(p(lso(W_1, W_2))), \quad (3)$$

where $lso(W_1, W_2)$ is the nearest common ancestor of (W_1, W_2) and $p(W)$ is the probability of W appearing in a specific ontology library.

Semantic distance algorithm: this algorithm is equivalent to calculating the semantic distance by using the conditional probability of child nodes after a common ancestor is given, and the semantic similarity is inversely proportional to the semantic distance:

$$Dist_{JC}(W_1, W_2) = 2 \log. \quad (4)$$

Semantic similarity algorithm: it can be regarded as a positive expression method of $D_{ist_{JC}}$ variant.

$$Sim_L(W_1, W_2) = \frac{2 \log}{\log(p(W_1))}. \quad (5)$$

Combined with the actual needs of the problem to be solved, the calculation formula of the correlation between the two words is summarized as follows:

$$SIM(x, y) = \frac{2 \times \text{con}(x, y)}{\omega_{in}(x)}. \quad (6)$$

In the formula, $\text{con}(x, y)$ refers to the frequency of x, y appearing in the same window unit in the selected document; $\omega_{in}(x)$ refers to the number of windows in which x appears in the selected document.

Considering the combination of similarity SIM and weight factor, the inter word correlation $SIMW(x, y)$ is finally obtained

$$SIMW(x, y) = SIM(x, y) \times \text{Weight Factor}(y). \quad (7)$$

Among

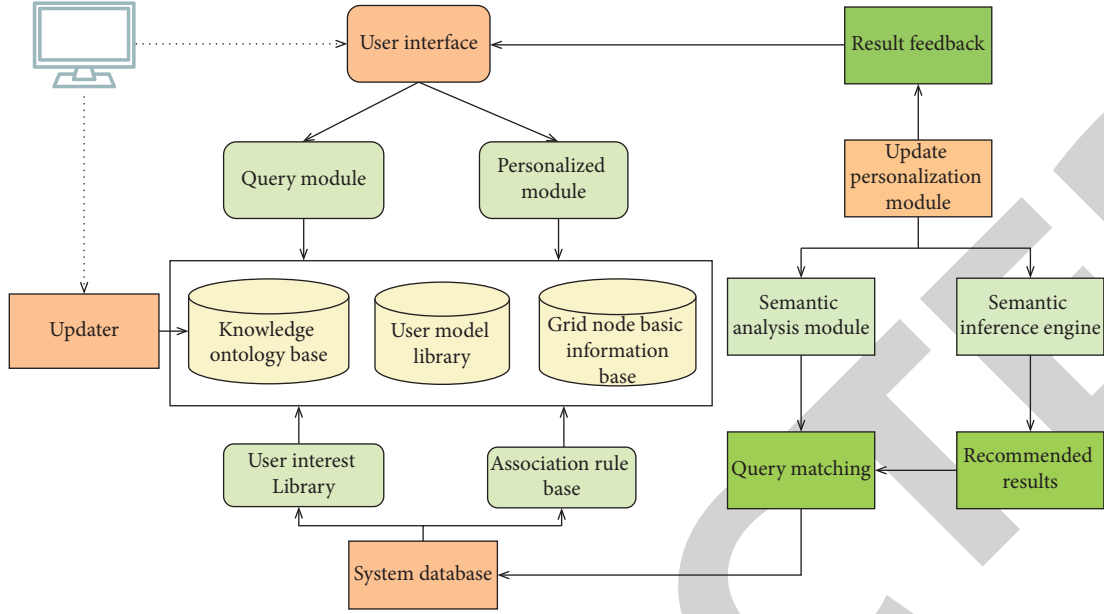


FIGURE 1: Flowchart of library document resource construction based on semantic web technology.

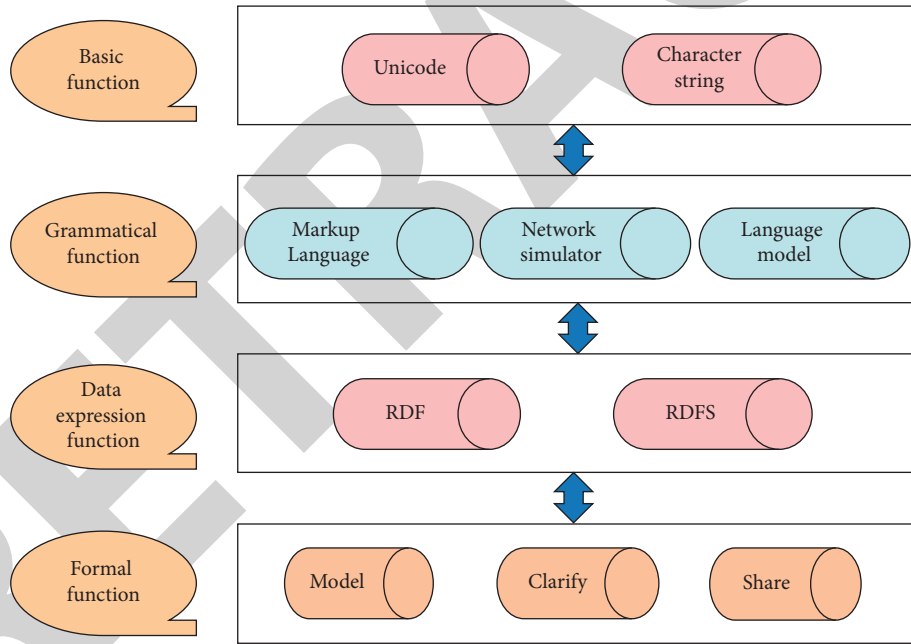


FIGURE 2: Semantic web technology construction model diagram.

$$\text{Weight Factor}(y) = \sqrt{\frac{\text{freq}(y)}{N_y}}, \quad (8)$$

where $\text{WeightFactor}(y)$ is the weight of the word y ; $\text{freq}(y)$ refers to the number of times y appears in the selected document; N_y indicates the number of occurrences of the word y in all documents of the whole corpus.

The two main indexes for evaluating the retrieval system are precision and recall, which are defined as

$$P = \frac{a}{b} \times 100\%, \quad (9)$$

$$R = \frac{a}{c} \times 100\%,$$

where a refers to the number of relevant problems retrieved; b refers to the number of all problems retrieved; c refers to the number of relevant questions in the question answer database.

At the same time, some library systems based on semantic technology have appeared abroad, the most typical of

which is JeromeDL, which realizes semantic retrieval and information interconnection of library systems through ontology technology and RDF language. The mode of adding semantics to text has been reflected in some software applications. Microsoft Office, for example, has a mode to display addresses, data, names of people, and places. If you need to find a name in the software, the software can provide the e-mail address of the name or open an empty e-mail address to give that name. Ontology is an effective means to represent domain conceptual model and structured domain knowledge, which is put forward under semantic web technology. Specifically, ontology is a conceptual model that describes concepts and the relationship between concepts, and describes the semantics of concepts through the relationship between concepts. Ontology technology has developed into one of the mainstream technologies of knowledge representation, knowledge management, knowledge sharing, and knowledge reuse and is becoming a core of common concern in research fields such as natural language processing, Web information retrieval, database and knowledge base management, heterogeneous data integration, digital library, GIS, and semantic web technology. Its advantages are that it can support semantic information management, reasoning implicit information, improving the automation degree of information management, and supporting the management of empirical information. Ontology is a complete set of words and terms that describe the knowledge in a certain field. According to the structure of the knowledge field, the compiler groups these words and terms into hierarchical categories and specifies the characteristics of categories and their relationships. The actual expression of the semantic web is much more complicated than it looks. They use RDF format and are often encoded in XML format. They widely use URL, an important processing method of computers, but it is a very friendly interface for readers.

Semantics is a distributed architecture composed of a large number of data that can be understood by machines. In this architecture, the relationship between data is expressed by some terms, and a complex network connection is formed between these terms. Computers can get the meaning of data through these terms and can use logic to reason on this connection, so as to complete some work that could not be completed directly. However, the semantic web does not appear as fast as people expect. The World Wide Web association has promoted its standards, but there are few practical application technologies of the semantic web. Part of the reason is the complexity of those important patterns, and those aspects of our application cannot effectively hide this complexity.

3.2. Construction of School Literature Resources.

Document resources are an important part of the school running conditions of institutions of higher learning, and their quality is directly related to the level of teaching and scientific research. The construction of document resources is one of the main tasks of university library. In the construction of document resources of university library, the

regulations point out that university library should formulate the construction scheme of document information resources according to the development objectives of the university and the needs of teaching and scientific research, and according to the overall arrangement of collection foundation and regional or systematic distribution of document resources, so as to form a collection system with the characteristics of the university. The application of modern information technology directly affects the scale of library collection and the level of document information guarantee ability. Therefore, the construction of library document resources should fully consider the environment of networked information resources. In resource construction, we should overcome the ideas of "small and complete" and "large and complete." Due to the strong heterogeneity of data resources in various departments of institutions of higher learning, to build a big data mining, analysis, and decision-making system based on university library, we need to collect, extract, clean, correlate, and analyze all kinds of data in various departments, explore the potential value of data, provide a solid analysis and decision-making driving model for the development of university library, and provide decision-making and analysis basis for the university and the library managers. The construction of document resources includes both micro and macro meanings. This paper mainly discusses the construction of document resources in the micro sense, that is, the collection, organization, management, and storage of documents by various document information institutions, that is, what we usually call collection construction. Book collection construction is a market behavior of interview decision-making on the basis of understanding the demand. It must deeply understand the demand. Under the dual constraints of benefit evaluation and supervision and document resource guarantee, the interview behavior of security systems at all levels will gradually strengthen self-control, actively establish the concept of coordination and sharing, and gradually move from randomness to standardization.

Because the personalized recommendation platform of the library makes use of the collaboration and data sharing of many departments in an institution of higher learning, and deeply aggregates the data information, it makes the interest model of student users more accurate, so that student users can obtain the useful resources in the library more accurately and conveniently. The evaluation object of collection efficiency and guarantee rate is libraries at all levels, not a virtual guarantee system, which determines the responsibilities and rights of guarantee systems at all levels. Fundamentally change the negative wait-and-see attitude towards the collection of new literature information carriers and the acquisition of information resources, and think that the network information resources can completely replace the library literature resources, thus neglecting the construction of library literature resources. And establish a book collection system suitable for the actual situation, so as to truly become an important document guarantee for school teaching and scientific research. At the same time, we should fully understand the publishing situation, carefully analyze readers' needs, study the existing collection structure, and

gradually form a collection structure with the characteristics of our school to meet the requirements of our school through continuous accumulation. The quality of literature resources construction directly affects the library collection structure and quality, and determines the overall service level of the library. The formation of the collection structure of university library depends on the long-term accumulation of literature resources construction. Only by doing the literature resources construction well in a down-to-earth manner can the service quality of university library be guaranteed. Every library should not only take part in the co-construction of literature information resources, make full use of the conditions provided by the network to realize the sharing of literature resources, but also master a reasonable scale of resource sharing, and strengthen the overall construction of literature information resources. Only in this way can the construction of library information resources achieve the goal of co-construction and sharing.

4. Results Analysis and Discussion

4.1. Experimental Analysis of Literature Construction. The State Council approved the division of disciplines in China into 12 categories, namely: philosophy, economics, law, pedagogy, literature, history, science, engineering, agronomy, medicine, military science, and management. According to this classification standard, the discipline categories of institution of higher learning listed in the sample table of institution of higher learning in Zhejiang, Shanghai, Guangdong, Sichuan, and Chongqing are counted. The results are shown in Table 1.

As can be seen from the statistical results in Table 1, among the five regions, the sample universities in Shanghai have the largest number of disciplines, reaching 12, accounting for 92.34% of the total number of disciplines, while Chongqing, which has the least number, has 10 disciplines, accounting for 83.25% of the total number of disciplines.

According to the sample university catalogues listed in the table, the number of readers in the school is counted, and the results are shown in Table 2.

It can be seen from Table 2 that the sample size of institution of higher learning in Zhejiang and Sichuan accounts for 28.67% of the total sample, and the proportion of readers accounts for 45.68% and 28.69% of the sample, respectively. The proportion of sample size of institution of higher learning in Shanghai, Guangdong, and Chongqing is 15.25%, but the proportion of readers is 6.25%, 9.68%, and 15.03%, respectively. This clearly shows that the scale of university library readers varies greatly from region to region.

The utilization situation is the main index to evaluate the value of literature resources in the university libraries. With the help of the circulation subsystem of the library, this experiment made statistics on all kinds of borrowing and returning situations from January to April 2021. Through the statistical results, we can intuitively see the circulation of various categories. In order to save space, only the following 4-month superimposed statistical line chart based on the 4-month statistical table is retained here. The horizontal axis is

10 categories, and the vertical axis is the circulation number. The experimental results are shown in Figure 3.

As can be seen from Figure 2, due to the limitation of the library's automation system, the original table picture of statistical data cannot be saved. However, from the intuitive graph, we can still see that the circulation situation of each month is strikingly similar. The four-month peak is in category H, followed by category D, category F, category F, category B, and category J. The big difference is the statistical data of March because it is a holiday.

To evaluate the economic effect of the investment scheme with the index of return on investment, it is necessary to compare it with the benchmark rate of return determined according to the historical data of similar projects and the wishes of investors. The method in document [6], the method in document [8], and the semantic web technology method in this paper are used for the experiment. In order to describe the change trend of the return on the investment of document resources of each member library after the operation of the document resource co-construction and sharing mode, the experimental results are shown in Figure 4.

As can be seen from Figure 4, in the broken line chart of the change of the return on investment in the co-construction and sharing of three kinds of document resources, we can intuitively see that the return on investment in document resources of each member library before and after joining the cooperation mode generally shows an upward trend, of which the upward trend of this method accounts for the highest.

In order to understand the practice of long-term preservation of digital resources in the Chinese libraries, this survey first counts the number of institutions that have carried out preservation activities in the investigated institutions. At present, the experimental results of the curve of preservation practice in libraries are shown in Figure 5.

As can be seen from Figure 5, most of the university libraries and the public libraries are carrying out preservation practice, while most professional libraries have not yet carried out preservation practice. Among the institutions that did not carry out preservation activities, 65.35% believed that due to the less practice of long-term preservation in China, it was necessary to observe for a period of time before deciding whether to carry out preservation activities; 36.48% of the institutions listed the financial factor and "digital resources have corresponding printed resources as backup" as the reasons for not carrying out preservation; 16.32% of the institutions affected their preservation because other institutions have preserved the same digital resources. In addition, another clearly pointed out that the main reason hindering its preservation activities was the lack of institutional guarantee.

This experiment investigates the funding of document resources in the university libraries. The experimental results are shown in Table 3.

According to the data in Table 3, in 2021, the purchase funds of library literature resources in three universities reached more than 30 million, and the per capita annual

TABLE 1: Statistics of disciplines in Colleges and Universities.

| Region | Zhejiang | Shanghai | Guangdong | Sichuan | Chongqing |
|----------------------------|------------------|------------------|---------------------------------|------------------|------------------|
| Sample size | 5 | 6 | 5 | 4 | 3 |
| Total of disciplines | 11 | 12 | 11 | 11 | 10 |
| Not involved in discipline | Military science | Military science | Military science and philosophy | Military science | Military science |

TABLE 2: Number of readers in university reader library.

| Region | Zhejiang | Shanghai | Guangdong | Sichuan | Chongqing | Amount to |
|-------------|----------|----------|-----------|---------|-----------|-----------|
| Sample size | 5 | 6 | 3 | 3 | 3 | 22 |
| Teacher | 13, 032 | 6, 34 | 2, 115 | 3, 257 | 3, 932 | 28, 373 |
| Student | 214, 966 | 142, 133 | 30, 782 | 47, 057 | 71, 182 | 506, 122 |
| Add up to | 228, 112 | 147, 168 | 32, 895 | 50, 315 | 75, 113 | 535, 494 |

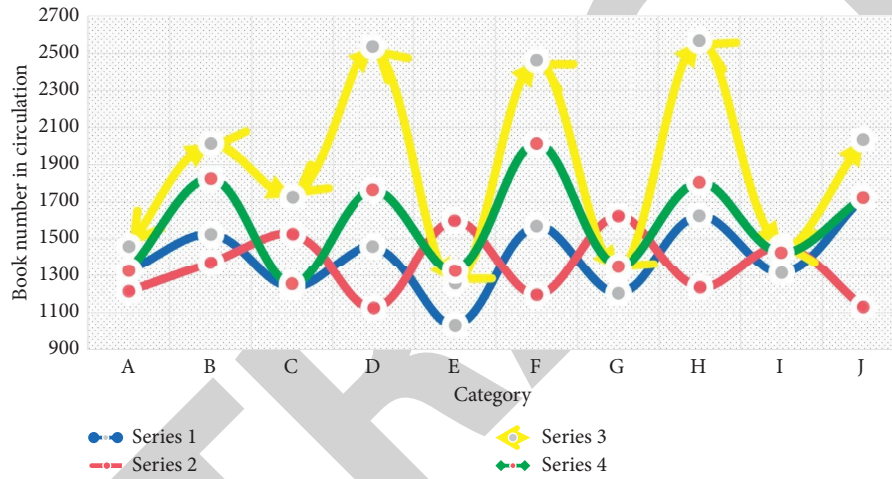


FIGURE 3: Changes of library book borrowing.

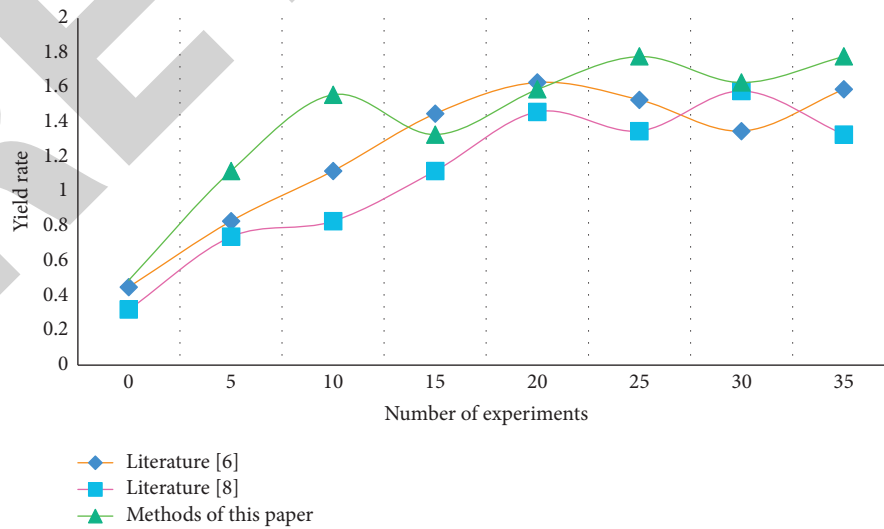


FIGURE 4: Line chart of the change of return on investment in co-construction and sharing of different literature resources.

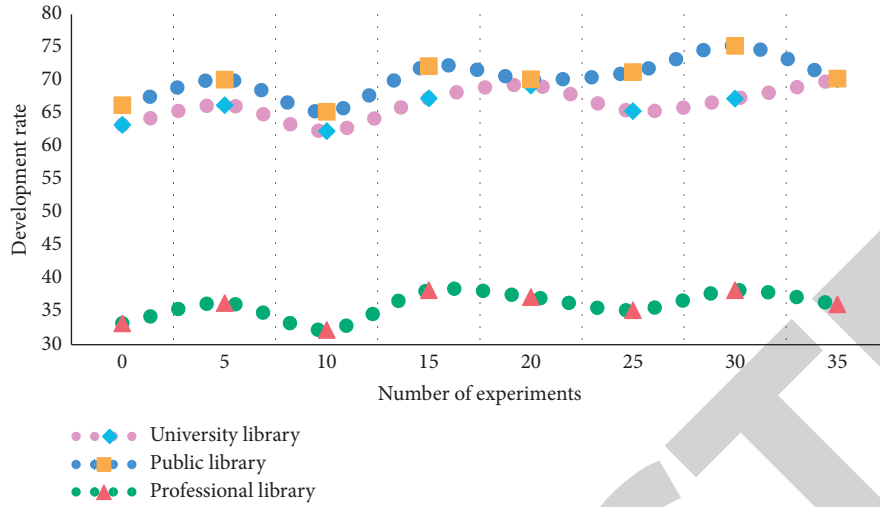


FIGURE 5: Change curve of preservation practice carried out by the library at present.

TABLE 3: Funding of document resources in the university libraries.

| School | Library funds | Number of students | Per capita expenditure |
|---------------------------------------|---------------|--------------------|------------------------|
| Zhejiang jiaotong university | 17, 159, 262 | 50,855 | 336.31 |
| Northwestern polytechnical university | 10, 322, 638 | 27,965 | 385.42 |
| Shanghai normal university | 10, 536, 472 | 34,715 | 321.92 |
| Total funds | | 38,018.372 | |
| Per capita expenditure | | 347.88 | |

expenditure of literature resources of students was close to that of 300 yuan. This fully proves that the funds for purchasing literature resources in the university libraries are huge, and the funds per student are relatively high.

For the long-term preservation modes of resources, such as institutional preservation, third-party preservation, and cooperative preservation, this survey invites institutions to sort the three types of preservation modes according to their preference. The experimental results are shown in Figure 6.

It can be seen from Figure 6 that, on the whole, Chinese libraries prefer to adopt the cooperative preservation mode. When the tendency index reaches 50, the tendency of the university libraries accounts for 58.5%, that of professional libraries accounts for 59.4%, and that of public libraries accounts for 66.54%. The number of preferred institutions' own preservation modes in public libraries is slightly higher than that of cooperative preservation; In the other two types of libraries, the number of institutions that choose the cooperative preservation mode still accounts for the majority.

This experiment is conducted according to the development trend of literature resources, and the experimental results are shown in Figure 7.

It can be seen from Figure 7 that among the institutions that choose to give priority to the development of library document resources in the development strategy of main document resources, 65.23% have carried out long-term preservation practice, compared with 57.42% of all

institutions. Due to the small number of samples, we cannot make simple statistical inferences, but it may reflect that institutions that pay attention to digital resources are slightly more proactive in implementing preservation activities than other institutions.

4.2. Empirical Conclusion. From the experimental results, the resources in the literature composition of the vast majority of institutions have been equivalent to those in the printed library, and most of the institutions will adopt the strategy of common development of printed resources and resources, and some institutions will take the strategy of giving priority to the development of library literature resources. The practical urgency of long-term preservation of library literature resources is self-evident. The vast majority of institutions will preserve or selectively preserve and purchase library literature resources, and more than half of institutions also prefer the library to undertake the responsibility of long-term preservation, which reflects the positive attitude of China's large library and information institutions towards long-term preservation. Each campus library is a parallel relationship regardless of the primary and the secondary. Under the guidance of the university's document resource construction planning and objectives, the document resource construction of each library is co-ordinated and cooperated to form a relatively independent

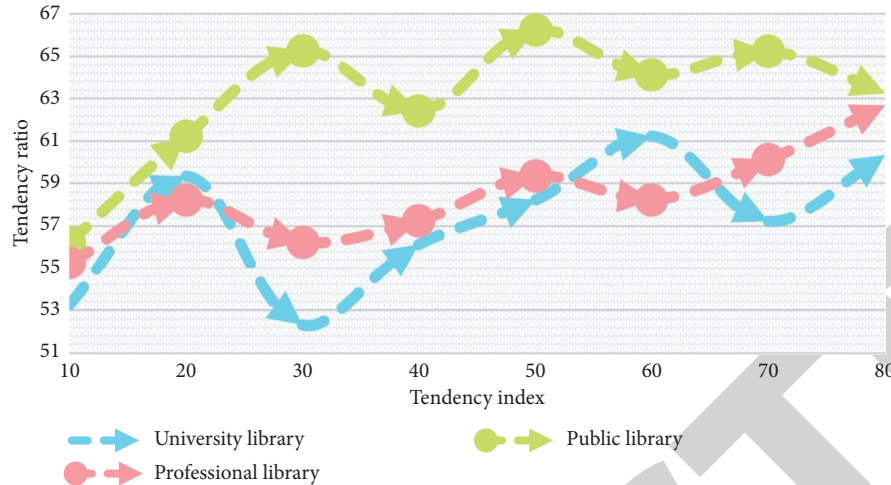


FIGURE 6: Library's tendency towards different preservation modes.

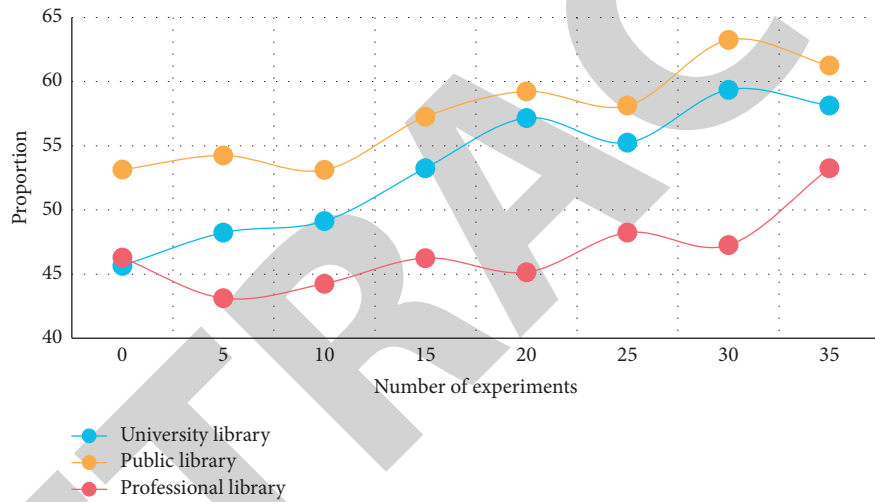


FIGURE 7: Development of main document resources in different libraries.

and distinctive book collection construction system. This model is suitable for multi-campus institution of higher learning arranged according to the school running levels of full-time education, vocational education and adult education.

5. Conclusions

Literature resource construction is a work with strong theory and practice. With the development of science and technology and the progress of society, the specific connotation of literature resource construction has changed correspondingly. Based on semantic web technology, this paper studies the construction of library literature resources. Among the institutions that choose to give priority to the development of library literature resources in the development strategy of main literature resources, the proportion of long-term preservation practice has reached 65.23%, compared with 57.42% of all institutions. Due to the small number of samples, we cannot make a simple statistical

inference, but it may reflect from the other side that the institutions that pay attention to digital resources are slightly more active in implementing preservation activities than other institutions. Under the semantic web technology, the carriers of literature information have also appeared diversified, which provides great convenience for the work of the acquisitioner. For decades, all kinds of libraries have basically formed their own literature resource structure and characteristics due to specific readers. This structure and characteristics are consistent with the needs of their clients, and have formed the literature guarantee system of each unit or even the region. At the same time, relying on the semantic web technology, the workflow such as the selection of bibliographic data, the formation and submission of orders, and the duplicate checking of bibliographies are all faster, which greatly shortens the literature procurement cycle and ensures the accuracy and scientificity of the procurement. With the development of document resources sharing, the construction of "characteristic" document resources oriented by semantic web technology needs will become the

Retraction

Retracted: Analysis of the Coupled and Coordinated Relationship between Emission of Carbon: International Growth of Economy-Conservation of the Environment in China

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Lan, "Analysis of the Coupled and Coordinated Relationship between Emission of Carbon: International Growth of Economy-Conservation of the Environment in China," *Mobile Information Systems*, vol. 2022, Article ID 9373389, 11 pages, 2022.

Research Article

Analysis of the Coupled and Coordinated Relationship between Emission of Carbon: International Growth of Economy-Conservation of the Environment in China

Zhenfeng Lan 

The Department of International Trade, College of Science and Technology, Ningbo University, Ningbo, Zhejiang 315300, China

Correspondence should be addressed to Zhenfeng Lan; lanzhenfeng@nbu.edu.cn

Received 13 May 2022; Revised 3 June 2022; Accepted 7 June 2022; Published 23 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Zhenfeng Lan. 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 coordinated and orderly development of both growth of economy and conservation of the environment is an important part of enhancing regional support capacity and achieving sustainable development. However, at the same time, the problem of environmental pollution and ecological damage in the province cannot be ignored more and more because of the lower resource utilization efficiency. The relationship between the emission of carbon and the growth of economy is a complex one. Energy, as an inherent driving factor of growth of economy, inevitably leads to the generation of emission of carbon while promoting the growth of economy. In such a context, how to reconcile energy consumption, emission of carbon, and economic growth is particularly important on the road to developing a low-carbon economy in China. The coordination of energy, economic, and environmental systems has a great impact on economic and social development, and only the coordinated development of energy, economic, and environmental systems is an important prerequisite to achieve sustainable economic and social development. This article frames the coupled coordination of emission of carbon international growth of the economy conservation of the environment in China and builds a theoretical foundation by defining relevant concepts and theories, summarizing the current situation of development, analyzing existing problems, and sorting out related mechanisms. The experimental results show that the results of $\ln c$, $\ln gdp$, and $\ln gdp^2$ are all at the 3% confidence level, so the coupled coordination model is very feasible. Therefore, this study can better play the role of the promotion between the two and use the coupled coordination model to quantitatively measure and analyze the coupling state of the emission of carbon and ecological environment in China, and deeply analyze the coupling state of growth of economy and ecological environment, so as to better realize the win-win situation of sustainable development of international growth of economy and protection of ecological environment.

1. Introduction

The dramatic increase in the energy emission of carbon driven by the growth of economy has led to global warming and caused a series of environmental problems [1]. The contradiction between energy conservation and emission reduction with the growth of economy and conservation of the environment is becoming increasingly prominent [2]. The long-term crude model of using material resource consumption to drive economic growth has not only distorted the economic structure and weakened the momentum of long-term growth of economy, but also polluted the environment, making environmental problems increasingly

prominent [3]. The most important and dominant greenhouse gas that affects temperature change is carbon dioxide, so the main task to stop global warming is to reduce the emission of carbon dioxide [4]. However, fossil energy consumption accelerates a country's economic growth and also brings a series of serious problems such as energy depletion, high foreign dependence, irrational consumption structure, environmental pollution, and ecological degradation [5]. This has become a bottleneck for economic growth to some extent and threatens the sustainable growth of a country's economy [6].

As an important material basis for the existence and development of human society, the strategic development of

energy has been related to the stability of national economy and society [7]. However, the dramatic increase in the energy emission of carbon driven by the growth of economy has led to global warming and caused a series of environmental problems [8]. The rising world sea level, the sharp decrease in species diversity, and the frequent occurrence of extreme weather pose a great threat to the living environment with human beings [9]. The intensification of the warming trend brings a series of ecological disasters, such as causing sea level rise, which directly threatens the survival and development of coastal and island countries [10]. International growth of economy and ecological environment are complex systems that are interconnected, mutually influencing, and mutually constraining, and the accelerated process of international growth of economy and the increasing level of growth of economy make the ecological environment face increasingly obvious pressures such as population, economy, and resources [11]. Therefore, how to coordinate the orderly development of growth of economy, emission of carbon, and environment is a problem worth studying.

The coordinated and orderly development of emission of carbon, growth of economy, and conservation of the environment is an important precondition for enhancing the comprehensive support capacity of the region as well as achieving sustainable regional development [12]. At the same time, the emission of carbon is also the key to achieve regional growth of economy and conservation of the environment and sustainable development [13]. Fossil energy consumption promotes high economic growth on the one hand, and on the other hand, there are problems such as supply and demand conflicts and energy security in the process of fossil energy consumption [14]. At the same time, the utilization process emits a large amount of carbon dioxide, causing a serious greenhouse effect, which in turn has a constraining effect on economic growth and threatens the economy to grow sustainably [15]. The first task to promote the construction of low-carbon international growth of economy is to correctly understand the coupling relationship between the two systems, and the correct understanding of this relationship includes two connotations. We construct an emission of carbon productivity and industry growth of economy index system, explore the coupling coordination degree of emission of carbon and industry growth of economy in China through the coupling coordination degree model and spatial exploratory analysis, and seek the influencing factors with greater correlation between the coordinated development of the two systems in each province and urban area. It provides theoretical basis and reference for each region to formulate differentiated and regionalized policies on low-carbon growth of economy and emission of carbon reduction.

The innovative points of this article are as follows:

- (1) This article first takes China's emission of carbon as the research object, and uses the coupling degree and coupling coordination model to make an overall evaluation and spatial and temporal difference analysis on the coordination level between China's economy and environment.

- (2) This article selects fossil energy consumption, which dominates the energy consumption structure, and carbon dioxide emission, which causes climate change and is of global concern, as the object of the study, together with economic growth.
- (3) From the perspective of industry, the relationship between emission of carbon and industry structure is studied by using the Kuznets curve of emission of carbon, which is a novel perspective to take industry structure as the research object.

The research framework of this article contains five major parts, which are organized as follows.

The first part of this article introduces the background and significance of the study, and then introduces the main work of this article. The second part imports the work related to the coupled coordination model with China's emission of carbon, international growth of economy, conservation of the environment coordination relationship. In the third part, the research methodology and the construction of the coupled energy-economic-environmental coordination model are reviewed, so that the readers of this article can have a more comprehensive understanding of the analysis of the coupled emission of carbon, international growth of economy, conservation of the environment relationship in China. The fourth part is the core of the thesis, which completes the description of the Kuznets curve of the emission of carbon and the weighting analysis of the indicators of the coupled coordination model from two aspects. The last part of the article is the summary of the full work.

2. Related Work

2.1. China's Emission of Carbon International Growth of Economy Conservation of the Environment Coordination Relationship. Eco-conservation of the environment seeks to achieve harmonious development between society, economy, resources, and conservation of the environment, changing the previous single development concept of GDP above all else and integrating the concept of development into economy, society, resources, and environment. More and more scholars are focusing on the harmonious relationship between the growth of economy and ecological environment. Because of the limitations of the social development stage, and economic and technological development level at that time, the research focus of different scholars also differs, and the conclusions reached will naturally be different.

Zhang et al. empirically analyzed the relationship between economic growth and environmental issues and concluded that the most important factors that play a role in the inverted U-shape are structural, technological, and scale effects [16]. Jiang et al. constructed an economic growth model including pollution factors to examine the negative effects of energy consumption under the assumption of endogenous technological progress, analyzed the impact of technological progress and environmental pollution on economic growth, and examined the optimal economic growth path in the presence of the dual constraints of

technological progress and environmental pollution [17]. Han et al. empirically investigated the Granger causality and cointegration of the relationship between the emission of carbon, economic income, and export trade, and the analysis resulted in the existence of a one-way Granger causality from economic income to the emission of carbon in Turkey [18]. Jia et al. found in their study of the relationship between energy consumption and GNP in the United States that when they used annual data from 1947 to 1979, they found no causality between energy consumption and GNP, while when the data were replaced with quarterly data, they concluded that there was only a one-way causality from GNP to energy consumption [19]. Zhang et al. measured the effect of economic income, energy intensity, and energy mix on the emission of carbon changes in Greece using the LMDI factor decomposition method and concluded that economic income has the greatest influence among these factors and that changes in economic income have a positive effect on the emission of carbon changes [20].

Global climate change and its impact on social and natural systems have been increasingly concerned by governments and the general public around the world, and the world is entering a new era of energy conservation and emission reduction. This is of great significance for the harmonious development of the growth of economy, emission of carbon, and environment.

2.2. Coupling Coordination Model. Integrating the development between economy, energy, and environment is necessary for China to take active measures to deal with the problem. Constructing a scientific and reasonable evaluation index system for the coupling and coordination degree of emission of carbon, economic, and environmental systems, and gaining an in-depth understanding of the current coupling and coordination degree of carbon, economic, and environmental systems in the western region can effectively assess the overall sustainable development status of the western region. To study the relationship between the emission of carbon and the growth of economy in China, carefully analyze the current situation and characteristics of China's carbon dioxide emissions, and identify the main problems and difficulties faced in developing a low-carbon economy. It is beneficial to deepen the understanding of theoretical issues related to the relationship between the emission of carbon and the growth of economy and the importance of development.

Xie et al. proposed the dualistic economic structure theory and pioneered the construction of an analytical framework for the interrelationship between industry and agriculture [21]. Wang et al. used the input-output model to analyze the relationship between energy policy and the environment and added influencing factors such as technology level variables and prices to the input-output model to study about variables related to energy policy such as energy consumption [22]. Zhang et al. studied that both energy and environment are important determinants of growth of economy and it is only by changing the structure of growth of economy that the quality of the environment

can be improved in a real sense [23]. Su proposed the concept of the impact of the growth of economy on the environment and studied the mechanism of the impact of the growth of economy on environmental factors [24]. Niyonzima et al. studied the relationship between energy consumption and GDP in the Philippines and Thailand. Niyonzima et al. used cointegration tests and error correction models to obtain a two-way causal relationship between the two [25].

Greening is a figurative expression to accelerate the construction of ecological civilization under the guidance of scientific development concept, which provides new ideas and new requirements for solving the resource and environmental problems encountered in the development of China's industrialization, informatization, urbanization, and agricultural modernization. The growth of economy needs to be built on the basis of sustainable development of the environment, and the special characteristics of the western region better reflect the importance of studying the degree of coupling and coordination of carbon, economic, and environmental systems in the western region.

3. Analysis of the Coupling Coordination Relationship among China's Emission of Carbon, International Growth of Economy, and Conservation of the Environment

3.1. Coupling Research Method. Energy is a material resource that provides power for human production and energy for life, thus ensuring the normal development of the national economy and the normal operation of people's lives [26]. Therefore, on the basis of following the principles of index system construction, the evaluation index system of the emission of carbon and growth of economy coordination is constructed [27]. Research based on the perspective of the coupled and coordinated relationship of the emission of the carbon growth of economy conservation of the environment triad system is important to promote the sustainable development of regional society and economy. The mechanism diagram of the emission growth of the economy conservation of the environment interaction is shown in Figure 1.

First, the growth of economy provides financial and technical support for the emission of carbon, which is conducive to improving the efficiency of the emission of carbon, increasing carbon productivity and thus promoting energy conservation and emission reduction. It must be objective, clearly defined, and also representative, and can truly reflect China's economic and environmental conditions, and can be effectively quantified. The coupled coordination degree model of the emission of carbon-economy-environment system is

$$G_{123} = f(X, Y, Z) = \sqrt{E_{123} \times (\alpha F_1 + \beta F_2 + \gamma F_3)}, \quad (1)$$

where α, β, γ are the undetermined coefficients.

Emission of carbon, as an undesired output of this study, is not directly available in the respective statistical yearbooks

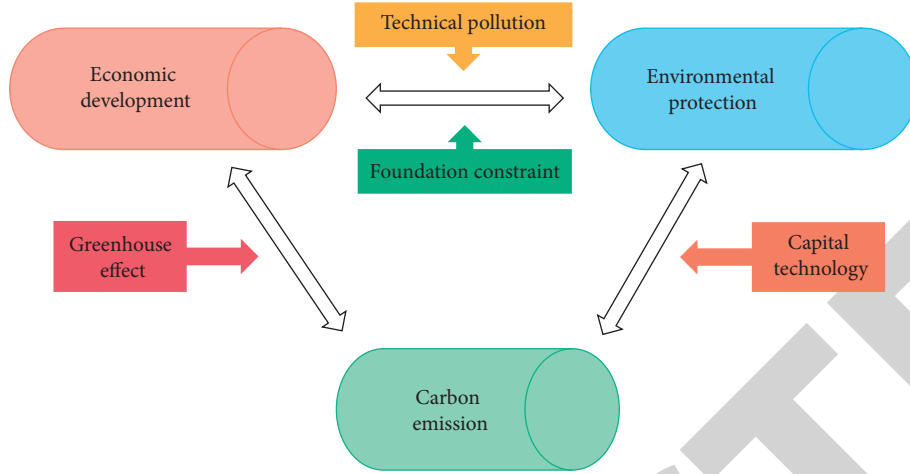


FIGURE 1: Interaction mechanism diagram of the emission growth the of economy conservation of the environment.

[28]. Therefore, it is necessary to calculate the emission of carbon of each region based on the values of the emission of carbon coefficients published by the United Nations Intergovernmental Panel on Climate Change. For the calculation of the degree of coordination borrowed the concept of fuzzy affiliation function, using real numbers between 0 and 1 to describe the coordinated development relationship between emission of carbon, growth of economy, and conservation of the environment in industrial areas, and its calculation formula is shown as follows:

$$D = \frac{\sum W_T \cdot W_J \cdot W_H}{\alpha \cdot k \cdot COE}, \quad (2)$$

where D is the coordination degree of emission of carbon, growth of economy, and conservation of the environment in industrial areas. α is the actual value of comprehensive level of growth of economy in industrial areas. k is the coordination coefficient of the emission of carbon, growth of economy, and conservation of the environment.

National energy supply data were used to calculate CO_2 emissions from the combustion of major fossil fuels [29], that is, by the apparent consumption of various fossil fuels in a country. Developed countries have achieved the inverted U-shaped path with the fastest speed by consciously or unconsciously going to restructure their economies as well as their energy consumption structures, which led to a situation where the environmental quality showed a low start to a later improvement while the economy kept growing [30]. Using the synergy theory spontaneously emerges as an orderly structure in time, space, and function through synergy within itself, thus improving the overall efficiency of the system. The principle of the synergy theory is shown in Figure 2.

Secondly, the emission of carbon counteracts the economy, as shown by the following: the higher the GDP output per unit of emission of carbon, the less constraint on growth of economy and the more beneficial to growth of economy. The emission of carbon per unit of energy consumption refers to the amount of carbon dioxide produced per unit of standard coal after converting the actual

consumption of various energy sources into standard coal usage and adding up. Based on the principles of data availability and representativeness, energy use efficiency, external dependence, industrial structure, and the degree of government intervention are selected as the main environmental factors that affect the efficiency of regional emission of carbon. The final formula of the coupled coordination degree of emission of carbon, growth of economy, and conservation of the environment in industrial areas is as follows:

$$CDH = \sqrt{C \cdot D}. \quad (3)$$

To construct the indicator system, it is necessary to ensure the operability of the selected indicators and to ensure that the selected indicators are simple and easy to collect for data calculation and analysis. The essence of the environmental Kuznets curve is to study the impact of the rapid growth of economy on environmental quality or resource consumption; that is, resource consumption or the environment is a function of growth of economy. The larger the emission of carbon per unit of energy consumption, the more the total emission of carbon, and vice versa, the smaller. The primary industry is chosen as the base value to calculate the industrial structure diversification coefficient, which is calculated as follows:

$$ESD = \sum \left(\frac{P}{\bar{P}}, \frac{S}{\bar{P}}, \frac{T}{\bar{P}} \right), \quad (4)$$

where ESD is the industrial structure diversification coefficient. P, S, T is the output value of primary, secondary, and tertiary industries.

Finally, the ecological environment provides natural resources and material security for growth of economy and is the basis for the growth of economy, but the higher cost of environmental treatment increases the economic burden when the environment is polluted. The production possibility set is determined from the original data, and the relative efficiency of the decision unit is calculated by comparing the individual decision unit with the determined

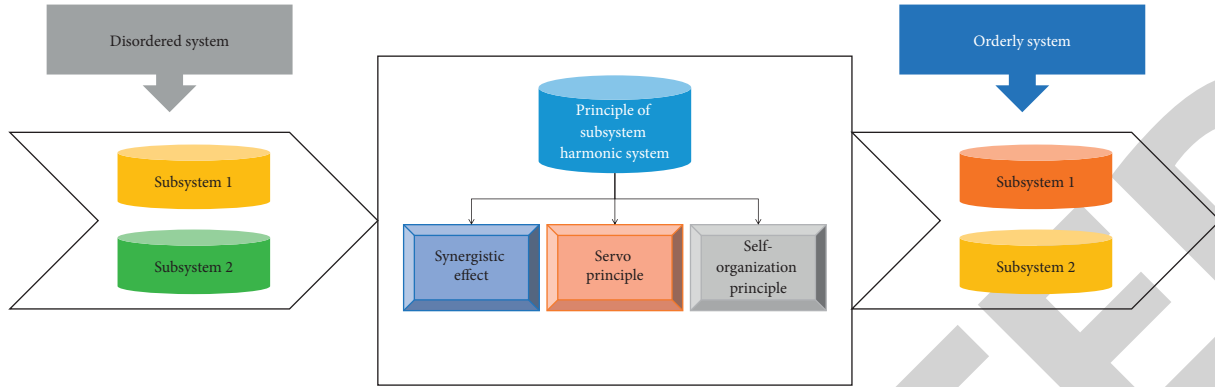


FIGURE 2: Principle of the synergetic theory.

optimal production frontier surface. The factor decomposition method is proposed according to the IPCC emission of carbon guidelines to calculate the emission of carbon from industrial zones with the following formula:

$$COE = \sum k \cdot COEF \cdot E \cdot V \cdot S, \quad (5)$$

where COE is the emission of carbon. k is the carbon dioxide emission coefficient of energy. COEF is the average low calorific value of energy. E is the content value of the unit calorific value of energy. V is the carbon oxidation rate of energy. S is the energy consumption.

There should be a certain logical relationship between the systems and between the indicators, and they should be able to reflect the characteristics of both economic and environmental systems in a comprehensive way, while the indicators should be constructed in a hierarchical way, and the indicators should be independent of each other and interconnected, reflecting the inner connection between the economic and environmental systems. When fossil fuels are used for nonenergy purposes, that is, as raw materials or materials, the carbon inside them is not emitted into the air in the form of CO_2 , as is the case with fuel combustion, which is what is meant by carbon sequestration. Since the “environment-economy” system is a large and complex system, its interactions are influenced by many other factors, such as geography, trade, technology, population, income distribution, and policy incentives.

3.2. Construction of the Energy-Economy-Environment Coupling Coordination Model. Energy consumption is used as an energy indicator, emission of carbon represents an environmental indicator, and gross domestic product (GDP) is used as a measure of growth of economy to simplify the study of the relationship between energy consumption, emission of carbon, and GDP. Coupling degree refers to the strength of system interaction, which is a measure of the degree of intersystem association and the interrelationship among the internal elements of the system, and can reflect the level of coordination between the economy and the environment of a country or a region. This article constructs a theoretical model of the interaction between economy and ecological environment, as shown in Figure 3.

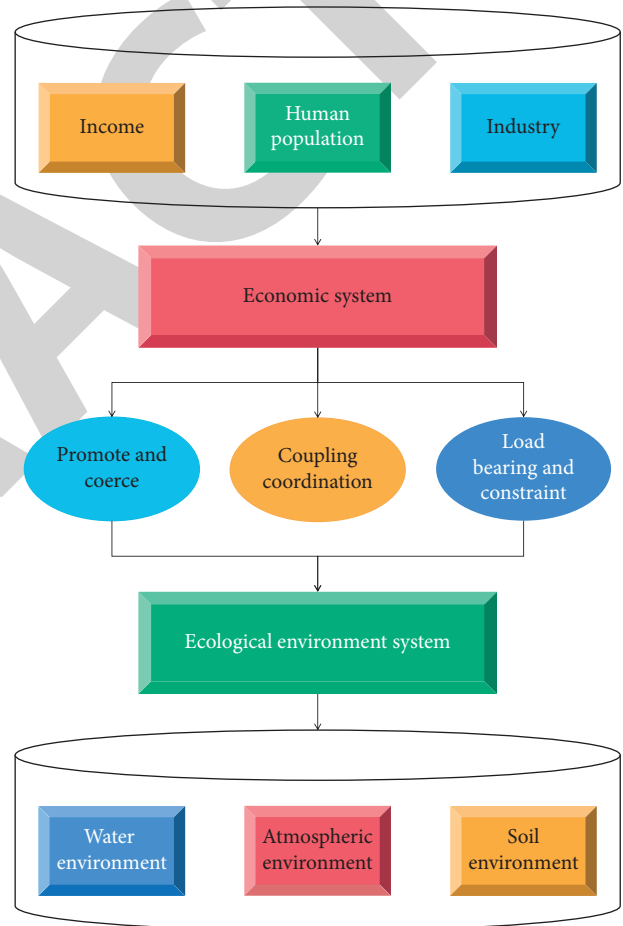


FIGURE 3: Theoretical model of interaction between economy and ecological environment.

The first is the macroeconomic module. The main applied to indicators includes gross domestic product, total population, industrial structure, and social fixed asset investment. Due to the interlocking and complex role of international growth of economy and ecological environment, the coupling degree and coordination degree models between two subsystems of international growth of economy and ecological environment are constructed by borrowing the capacity coupling coefficient model in physics. The

coupling coordination degree model between the carbon-economy system, carbon-environment system, and economic-environment system both can be written as

$$\begin{aligned}
 G_{12} &= f(X, Y) \\
 &= \sqrt{E_{12} \times (\mu F_1 + \nu F_2)}, \\
 G_{13} &= f(X, Z) \\
 &= \sqrt{E_{13} \times (\mu F_1 + \omega F_3)}, \\
 G_{23} &= f(Y, Z) \\
 &= \sqrt{E_{23} \times (\nu F_2 + \omega F_3)}.
 \end{aligned} \tag{6}$$

Time series data and cross-sectional data are used for the study. The cross-sectional data are used to summarize whether different economic behaviors are correlated by showing the correlation between each variable through the estimation results of model parameters. Assuming that the contribution of each of the x subsystems to the overall system's integrated development level is the same, the overall system's integrated development level F is calculated by the following formula:

$$F = \frac{F_1 + F_2 + \dots + F_x}{x}. \tag{7}$$

The primary, quadratic, and cubic GDP per capita are usually used, and sometimes, some control variables are included, which mainly contain influencing factors such as population size, technology level, foreign trade, policies to protect the environment, and economic structure. The global spatial autocorrelation can test whether there is spatial dependence of regional emission of the carbon growth of economy conservation of the environment coupling coordination, and analyze the spatial correlation pattern and spatial clustering pattern of China's emission of carbon growth of economy conservation of the environment coupling coordination from a regional perspective as a whole. According to the classification of primary energy sources, the energy sources at the beginning of industrialization are mainly coal, so the consumption of coal is used as the base value to calculate the energy structure diversification coefficient, and the calculation formula is

$$ECSD = \sum \left(\frac{C}{C}, \frac{O}{C}, \frac{G}{C}, \frac{E}{C} \right), \tag{8}$$

where COE is the energy diversification coefficient. C is the coal consumption. O is the oil consumption. G is the natural gas consumption. E is the hydropower consumption.

Next is the energy demand module. Mainly applied to the indicators' total energy consumption, energy structure and energy intensity focus on the geospatial effect, that is, the detailed presentation of the geospatial nature of the data of the research object on the geospatial performance. Therefore, the coefficient of variation is used for the derivation of the economic and environmental coupling degree calculation model. When comparing the dispersion of two groups of data, it is not appropriate to use the standard deviation

directly for comparison if the metric scale of the two groups of data is too large or the data outline is different. The concept of capacity coupling is used as the theoretical basis to calculate the coupling degree of the emission of carbon, growth of economy, and conservation of the environment in industrial areas, and its calculation formula is shown as follows:

$$C = \frac{W_T W_J W_H}{COE}. \tag{11}$$

where C is the coupling degree of emission of carbon, growth of economy, and conservation of the environment in industrial areas. W_T is the weight value of the emission of the carbon index. W_J is the weight value of the growth of the economy index. W_H is the weight value of the conservation of the environment index. COE is the emission of carbon.

The global spatial autocorrelation only describes the spatial distribution pattern in general, but it averages out the differences between regions and cannot specifically reflect the high and low distribution status of values and the degree of spatial differences in each region. Therefore, based on the static coordination measure of emission of carbon and growth of economy, the continuity of the coordination state of emission of carbon and economy is considered.

Finally, there is the environmental module. The main indicator used is the emission of carbon, where the data underlying the measurement of emission of carbon are obtained from the database of the energy demand module. The Moran index is used to analyze whether the ternary coupling of coordination produces significant differences between the central and peripheral regions. Emission of carbon indicates energy use and consumption. As the basis of sustainable development of industrial base, it is necessary to improve the emission of carbon efficiency as much as possible in the process of energy development, processing, and use and consumption, which includes the emission of carbon technical efficiency and emission of carbon scale efficiency. Therefore, the hot spot analysis method is needed to reflect more comprehensively the distribution status of high and low values of the coupled emission of carbon growth of economy conservation of the environment coordination in each province and the change trend of spatial differences, and to reveal the local spatial distribution characteristics. By quantifying the magnitude of the comprehensive economic and social efficiency function and the comprehensive energy and environment efficiency function of developing countries on the degree of coupled coordinated development, the degree of coupled coordination between the economic and social development subsystem and the energy and environment subsystem can be reflected more intuitively and the calculation results of the model can be more objective and credible.

4. Emission of Carbon Kuznets Curve and Model Index Weight Analysis

4.1. Analysis of Emission of Carbon Kuznets Curve. The complexity of economic phenomena and the development needs of economic theories, zhi'shi simply applying cross-

sectional data or time series data to illustrate economic problems has been somewhat inadequate. The basic idea of environmental Kuznets curve is that in the early stage of growth of economy, achieving economic growth is the main goal people pursue, and in order to obtain more social wealth, they will ignore or even sacrifice the environment to promote economic growth. Therefore, a quadratic function is chosen here to verify whether there is a Kuznets curve hypothesis between the emission of carbon and economic growth, that is, whether there is an inverted U-shaped relationship between the two. The coal-based energy consumption structure and rapid growth of economy jointly determine the characteristics of China's emission of carbon, the value of China's total emission of carbon between 2011 and 2021, and the output is shown in Figure 4.

First, the analysis of the emission of carbon Kuznets curve is performed to test which model forms the sample data fits in order to avoid model setting errors and thus improve the validity of the parameter estimates. When dissecting the energy consumption factors, industrial structure, fixed asset investment, energy production, total population, total economy, and emission of carbon are considered. Because the nature of each indicator and data units are different, it is necessary to dimensionless the indicators, that is, to standardize or normalize the indicators that cannot be directly integrated, so that the influence of the units of measurement of the indicators is eliminated. The structure of the three major industries has changed significantly, and the national economic growth has shifted from being driven by the primary and secondary industries to being driven mainly by the secondary and tertiary industries, and the heavy-duty industrial structure is not conducive to China's goal of energy conservation and emission reduction. The change in the structure of the three major industries in China between 2012 and 2021 is shown in Figure 5.

At the same time, the comprehensive technical level is treated as a variable, which is expressed by the comprehensive level of labor quality index and technology market turnover. This is because the comprehensive technical level is regarded as a constant, which has its limitations.

Secondly, the constant parameter model, variable intercept model, and variable coefficient model are used to regress the sample data to obtain the residual sum of squares, and then, the residual sum of squares is used to construct the F test statistic. In order to make the analysis results more objective and accurate, we need to convert the GDP data to the real GDP calculated by the GDP deflator in constant prices. No longer limit the analysis of the impact of economic growth and emission of carbon on energy consumption, but also make the analysis of the impact factors more reasonable. In the analysis of emission of carbon factors, based on the operability of the research method, the paired sample test is applied to test whether there is a significant difference between the emission of carbon efficiency, pure technical efficiency, and scale efficiency measured by the traditional DEA model and the emission of carbon Kuznets curve, and the test results are given in Table 1.

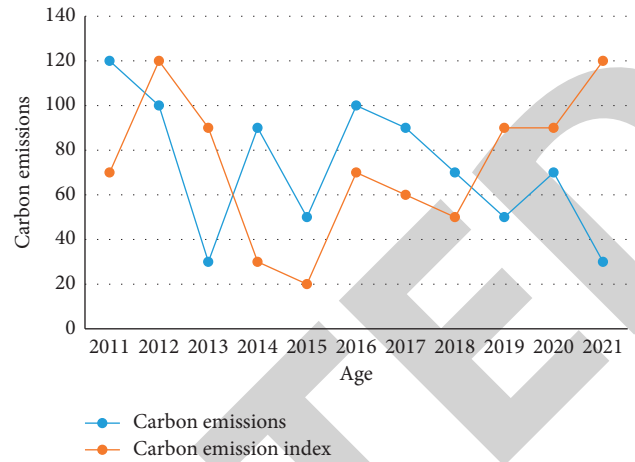


FIGURE 4: Trends of emission of carbon in China.

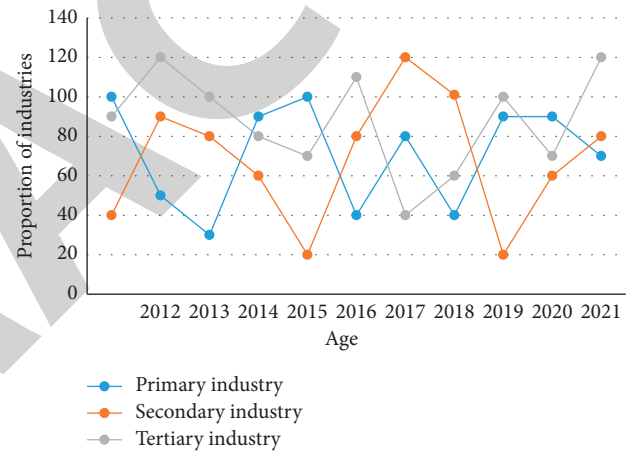


FIGURE 5: Changes of three major industrial structures.

The main purpose is to analyze the factors influencing the emission of carbon per capita and further examine the impact of energy consumption and economic growth on the emission of carbon. The apparent consumption calculation can determine whether there is a long-term equilibrium relationship between GDP and variables such as coal consumption, human capital, fixed capital, and integrated technology level in the western region. The data on international route bunkering and inventory changes in apparent consumption are omitted because they are relatively small, so some scholars directly simplify the definition as production plus imports minus exports, or refer to production plus net imports or production minus net exports. The coefficient of variation and Gini coefficient are used to explore the time variation pattern of China's overall emission of carbon efficiency, and the results are shown in Figure 6.

Finally, considering the effect of the cross-sectional heteroskedasticity problem due to different regions of the sample and the contemporaneous correlation on the estimation validity, the corresponding generalized least squares

TABLE 1: Test results of paired samples.

| | Emission of carbon efficiency | Pure technical efficiency | Scale efficiency |
|----------------------|-------------------------------|---------------------------|------------------|
| <i>T</i> value | 3.227 | 4.293 | 5.184 |
| Test of significance | 0.178 | 0.093 | 0.051 |

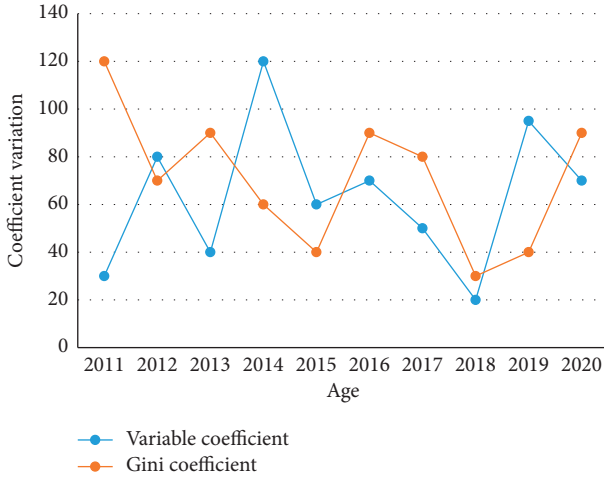


FIGURE 6: Changes of Gini coefficient and variation coefficient of emission of carbon efficiency.

method is chosen to estimate the model in order to eliminate the cross-sectional heteroskedasticity and contemporaneous correlation. The panel analysis takes into account the effect of regional heterogeneity on the interrelationship between the three. The panel data for its analysis are obtained from the corresponding database. Since Chinese authorities do not explicitly give potential emission of carbon factors for the various fuels used in the country, they are usually specifically tested experimentally or use internationally common parameters that are recommended for use. Therefore, the upstream industry is mainly responsible for the supply of raw materials for water projects. Price fluctuations directly affect the industry costs and profits, and changes in the downstream investment vane directly affect the industry market size.

4.2. Index Weight Analysis of the Coupling Model.

Assigning weights by the subjective assignment method is easy to affect the true accuracy of indicators. In the evaluation of ecological environment and other fields, the entropy method is much applied, so the entropy method is used to determine the weights. According to the basic principle of information theory, information is used to measure the orderly degree of the system, while entropy is used to measure the disorderly degree of the system. If the degree of variation of an indicator in the system is greater, the more effective information it carries, and the greater its weight. The results of the calculation of the integrated development level of the economic system and the integrated development level of the environmental system are analyzed by

using the scatter diagram to analyze the trend of the three terms, and the obtained trend diagram is shown in Figure 7.

First, since some data are zero, a positive number slightly greater than zero needs to be added to the processing results of such data, using the addition of 0.01 for processing, which can avoid the meaningless number of assignments. Because the original values of each index not only differ greatly in size but also have different units of measurement and are not comparable, it is not scientific to judge them directly. The coupling degree reflects the quantitative degree of coordination between green finance and green industry, and it can be seen from the model that the value of coupling degree is between 0 and 1, and the larger the value, the better the coupling, and vice versa, the worse the coupling. Therefore, the indicators must be dimensionless to make them comparable and dimensionless, so that they can directly reflect the effect on the growth of economy and ecological environment system. The trapezoidal area method is used to obtain the Gini coefficients of energy consumption distribution and environmental consumption distribution, and the area under the Lorentz curve is approximated as a number of trapezoids for calculation. According to the properties of indicators, there are two types of indicators: positive indicators, that is, the larger the value, the more beneficial to the system development, and negative indicators, that is, the smaller the value, the more beneficial to the system development. The positive indicator refers to the indicator whose system state level becomes better as the value of the indicator increases, and the negative indicator refers to the indicator whose system state level becomes better as the value of the indicator decreases. Considering that there may be spatial differences and spatial correlations among the panel data, LLC test, Fisher-PP test, and Fisher-ADF test are selected to determine whether the coupled coordination model is smooth. The test results are given in Table 2.

Although the results obtained by the various tests are different, the results of the tests indicate that the coupled coordination model is feasible at the 3% confidence level when the level values of $\ln c$, $\ln gdp$, and $\ln gdp2$ are tested, whether the constant term is included in the test equation or the time trend term and the constant term are included.

Secondly, SPSS software was used to conduct factor analysis on the first-level indicators to derive the contribution rate and cumulative contribution rate of each first-level indicator, and the top n factors were extracted as the analysis factors according to the contribution rate. The coupling coordination degree is applicable to the quantitative evaluation and comparison of the coordinated development of green finance and green industry in different periods in the same region, which has strong practical significance. Therefore, the coupling coordination degree

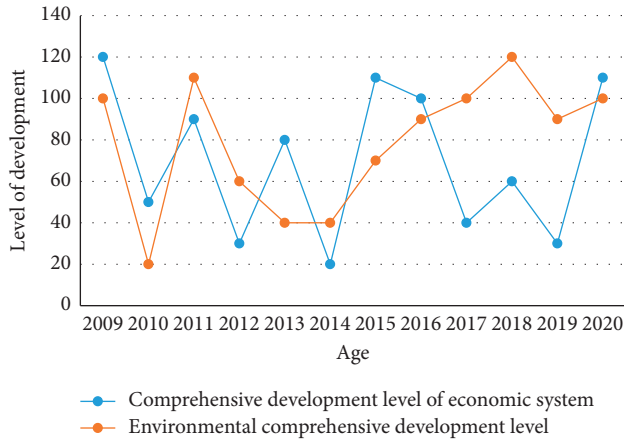


FIGURE 7: Trend line of comprehensive development level of the economic-environmental system.

TABLE 2: Panel unit root test results.

| | Inc | Lngdp | Lngdp2 |
|-----------------|---------|---------|---------|
| LLC test | -2.1866 | -2.0051 | -1.9832 |
| Fisher-PP test | -1.7823 | -1.6349 | -0.7841 |
| Fisher-ADF test | -1.5642 | -0.9842 | -0.7648 |

function was created to calculate the energy consumption or water consumption per unit of output value, the emission of three wastes, and the comprehensive energy and environment consumption, and to rank each industry from the smallest to largest accordingly. To determine the similarity of the curve of each index series, the degree of correlation among the factors is determined, and the main factors affecting the target value in the system are sought to promote the benign development of the system. The actual value of the coupled emission of carbon-economy-environment system was selected as the input value, and the actual value of the coupled emission of carbon-economy-environment system was selected as the output value for the training test, and the test results are shown in Figure 8.

Finally, the scores of each secondary indicator in the three indicator systems of emission of carbon, growth of economy, and conservation of the environment are then derived from the scores of the analyzed factors and then synthesized to derive the primary indicator weights. Based on the ranking, the cumulative percentage of output value and the cumulative percentage of energy consumption or water consumption, three waste emissions, and combined energy and environment consumption are calculated and plotted as the horizontal and vertical coordinates of the Lorentz curve, respectively. The evaluation of coupled economic-social-energy-environmental coordination in developing countries takes economic-social and energy-environmental subsystems as subsystems, and defines the degree of coordinated development between economic-social subsystems and energy-environmental subsystems and between system elements as the degree of coupled economic-social-energy-environmental coordinated development.

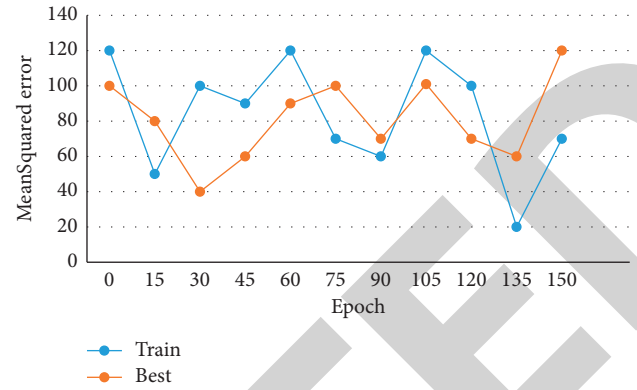


FIGURE 8: Relationship between error and specific training times.

When comparing the degree of variation of multiple targets, if the units or mean values are the same, their standard deviation can be directly used to compare; if the units or mean values are different, the ratio of the standard deviation to the mean value should be used to compare the degree of variation.

5. Conclusions

Along with the global warming climate and the deteriorating resources and environment, it has become a broad consensus in the international community to improve carbon productivity and develop a low-carbon economy. On the issue of climate change, a large number of studies and meteorological observation facts show that the total amount of carbon dioxide in the atmosphere is increasing, the concentration is rising, and the global climate is warming. Climate warming has seriously threatened the survival of human beings and at the same time seriously affected the continuous development of economy, society, and environment. The world has started to pay much attention to the problem of climate warming among environmental issues, and people have started to take various measures to cope with the problem of climate warming. Nowadays, most studies focus on analyzing the relationship between energy, economy, and environment, but few studies at the national level consider the three factors in one system and few in-depth studies at the industry level. In this article, on the basis of combing related research literature and theoretical borrowings, a simplified coupled energy-economy-environment coordination model is constructed as the theoretical mechanism for the empirical study of this article, which argues that energy-environment-economy is a system of mutual influence, and the mutual influence relationship between energy consumption, emission of carbon, and economic growth in China should be systematically. This study can provide a theoretical and decision-making basis for the policy and system formulation of governmental departments in the synergistic strategy of industrial zones, which is conducive to joint actions in the conservation of the environment, growth of economy, and emission of carbon in industrial zones, and provides a reference basis for coping with the infinite environmental pollution and limited

economic resource possibilities to show better coupling and coordination.

Data Availability

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

Conflicts of Interest

The author declares that there are no conflicts of interest.

References

- [1] J. Wang, X. Dong, and K. Dong, "How digital industries affect China's carbon emissions? Analysis of the direct and indirect structural effects," *Technology in Society*, vol. 68, Article ID 101911, 2022.
- [2] X. Jiang, K. Zhu, and S. Wang, "The potential for reducing China's carbon dioxide emissions: role of foreign-invested enterprises," *Global Environmental Change*, vol. 35, pp. 22–30, 2015.
- [3] Z. Gang, "China's economic development and environment protection," *China Report*, vol. 43, no. 2, pp. 203–211, 2007.
- [4] Q. Dong and A. Wang, "Coordination between economic development and environmental protection in free trade zone: a case study of Hubei, China," *Nature Environment and Pollution Technology*, vol. 17, no. 1, pp. 195–202, 2018.
- [5] J. Liu and P. H. Raven, "China's environmental Challenges and Implications for the world," *Critical Reviews in Environmental Science and Technology*, vol. 40, no. 9–10, pp. 823–851, 2010.
- [6] Y. H. Meng, Y. T. Feng, and Y. Zhao, "Impact of carbon emissions on economic factors and economic growth in China's underdeveloped regions: Evidence from Guangxi Zhuang Autonomous Region," *Ecological Economy*, vol. 17, no. 2, p. 17, 2021.
- [7] Y. Zhou, R. Peng, and H. Hu, "Coupling coordination and spatial differentiation between urbanization and eco-environment: case study of Ya'an, China," *Geojournal*, vol. 22, no. 3, pp. 1–20, 2021.
- [8] F. Zhao, W. Zhang, and Y. Wang, "Quantifying the coordination of energy development and environmental protection: a case study of China," *Energy Procedia*, vol. 104, pp. 520–525, 2016.
- [9] X. Zhao, Y. Zhao, S. Zeng, and S. Zhang, "Corporate behavior and competitiveness: impact of environmental regulation on Chinese firms," *Journal of Cleaner Production*, vol. 86, pp. 311–322, 2015.
- [10] M. Xu and W.-Q. Hu, "A research on coordination between economy, society and environment in China: a case study of Jiangsu," *Journal of Cleaner Production*, vol. 258, no. 2, Article ID 120641, 2020.
- [11] W. Zhou, M. I. Hong, and W. Zhou, "China's carbon emissions: international comparison and Mitigation Strategies," *Resources Science*, vol. 32, no. 8, pp. 1570–1577, 2010.
- [12] C. Yue, S. Wang, and J. Zhu, "Carbon emissions Projection for China(carbon emissions and social Development, IV)," *Bjing Daxue Xuebao Ziran Kexue Ban/Acta entiarum Naturalium Universitatis Pekinensis*, vol. 46, no. 4, pp. 517–524, 2010.
- [13] D. U. Qiang, C. Qiao, and L. U. Ning, "Forecast of China's carbon emissions based on modified IPAT model," *Prediction of China's future carbon emissions based on improved IPAT model*, *Journal of Environmental Sciences*, vol. 32, no. 9, pp. 2294–2302, 2012.
- [14] W. Yong, Z. Yu, and L. Zhu, "Influencing factors and Decoupling Elasticity of China's transportation carbon emissions," *Energies*, vol. 11, no. 5, p. 1157, 2018.
- [15] L. T. Fang and K. M. Li, "A study of the relationship between China's energy consumption for environmental protection and economic growth," *Advanced Materials Research*, vol. 600, pp. 67–70, 2012.
- [16] Y. Y. Zhang, H. T. Zhou, and I. Younis, "Coupling coordination analysis of technological innovation, standards, and quality: Evidence from China," *Sage Open*, vol. 11, no. 3, pp. 476–490, 2021.
- [17] T. Jiang, Y. Yu, and B. Yang, "Understanding the carbon emissions status and emissions reduction effect of China's transportation industry: dual perspectives of the early and late stages of the economic "new normal"," *Environmental Science and Pollution Research*, vol. 27, pp. 1–14, 2022.
- [18] X. Han, Y. Xu, A. Kumar, and X. Lu, "Decoupling analysis of transportation carbon emissions and economic growth in China," *Environmental Progress & Sustainable Energy*, vol. 37, no. 5, pp. 1696–1704, 2018.
- [19] Z. Jia, C. Jwab, and B. HJ, "A review of development and reform of emission permit system in China," *Journal of Environmental Management*, vol. 247, pp. 561–569, 2019.
- [20] L. Zhang, J. Pang, X. Chen, and Z. Lu, "Carbon emissions, energy consumption and economic growth: Evidence from the agricultural sector of China's main grain-producing areas," *Science of the Total Environment*, vol. 665, pp. 1017–1025, 2019.
- [21] Y. Xie, L. Zhang, and X. Gong, "Empirical study of the coupling relationship between biodiversity and environmental geology under different ecological status: Evidence from five typical areas in Guizhou, China," *Environmental Science and Pollution Research*, vol. 46, pp. 1–13, 2022.
- [22] K. Wang, Y. Tang, Y. Chen et al., "The coupling and coordinated development from urban land using Benefits and urbanization level: case study from Fujian province (China)," *International Journal of Environmental Research and Public Health*, vol. 17, no. 16, p. 5647, 2020.
- [23] K. Zhang, J. Shen, R. He, B. Fan, and H. Han, "Dynamic analysis of the coupling coordination relationship between urbanization and water resource security and its Obstacle factor," *International Journal of Environmental Research and Public Health*, vol. 16, no. 23, p. 4765, 2019.
- [24] H. Su, "Performance Audit of carbon emission intensity in Chinese Inland and coastal areas," *Journal of Coastal Research*, vol. 115, p. 451, 2020.
- [25] P. Niyonzima, X. Yao, and E. K. Ofori, "How do economic growth and the emissions of carbon dioxide relate?" *Open Access Library Journal*, vol. 9, no. 3, p. 16, 2022.
- [26] Y. Chen, H. Lu, and J. Li, "Effects of land use cover change on carbon emissions and ecosystem services in Chengyu urban agglomeration, China," *Stochastic Environmental Research and Risk Assessment*, vol. 34, no. 5993, 2020.
- [27] Y. Zhang and C. Shao, "Ideas and Countermeasures for Optimum Design of environmental protection system based on ecological security," *IOP Conference Series: Earth and Environmental Science*, vol. 267, no. 6, Article ID 062011, 2019.
- [28] L. Zhang.Zhang, "Legal framework and practice for environmental protection and application of green energy in

Retraction

Retracted: Space Modeling Design Art of Suspense Movies Based on Machine Vision

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Zuo, "Space Modeling Design Art of Suspense Movies Based on Machine Vision," *Mobile Information Systems*, vol. 2022, Article ID 8149182, 9 pages, 2022.

Research Article

Space Modeling Design Art of Suspense Movies Based on Machine Vision

Zhicheng Zuo 

Department of Film Press and Contents, Cheongju University, Cheongju 28503, Republic of Korea

Correspondence should be addressed to Zhicheng Zuo; 184160415@smail.cczu.edu.cn

Received 13 May 2022; Revised 3 June 2022; Accepted 8 June 2022; Published 23 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Zhicheng Zuo. 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.

After suspense movie space has a substantial role, it plays an irreplaceable role in movie narration. Different spatial forms can give us different feelings and different spatial feelings and can cooperate with different stories to create a different atmosphere. In this paper, a new 3D human behavior recognition algorithm in MV (machine vision) perception is proposed. The new algorithm is achieved by collecting the human behavior images and detecting the contour areas of the images. By reducing the projection area of the spatial positioning error area of unknown nodes on the plane, the positioning accuracy of unknown nodes in each axis direction is improved. The necessary brightness correction and color saturation compensation are carried out in color space. The results show that the average recognition rate of human behavior in MV perception is 95%, which can effectively improve the recognition accuracy. The enhanced color image is not only clearer but also more vivid and bright, which achieves the expected purpose.

1. Introduction

The specific time and space in movies are perceived and then used, which shows that it has an inseparable relationship with the formation of art. Indoor furnishings, props, and the use of colors are the most important presentation ways of movie space. As a space design art, these presentation ways will be displayed one by one with the promotion of the film plot. Not only does a successful suspense movie depend on novel drama structure, complex plot setting, superb suspense presupposition, and the ability to control details, but also the artistic processing and treatment of indoor and outdoor scene space in the movie will play a particularly crucial role. Many suspense movies are based on mystery novels as script prototypes. However, an excellent suspense film can be completed by more than just a mystery script. The difference between suspense films and other types of films is that they have different narrative characteristics from other types of films. The open space often gives people the feeling of freedom, and different spatial forms add a lot of functions to the creation of story atmosphere, laying the foundation for the expression of story theme.

As the basis of film space theory research, space theory provides a clear direction for it. Marsen et al. think that space contains new meaning and philosophy in controlling film narrative, and film space will become an important way of existence and a dimension of film narrative [1]. Mun roughly analyzed the characteristics of movie interior scene design from the aspects of creating environment atmosphere, highlighting local characteristics and deepening the theme of the film, as well as the related matters needing attention in the scene design in movie creation [2]. Sinka broke the boundary between language and design by using the cross study of rhetoric and interior space design. With reference to the research methods of traditional language rhetoric theory, it systematically analyzes and summarizes the expression of indoor space language from the perspective of “literary description” [3]. It is believed that space has new meaning and philosophy, and it has become a new form that dominates film narration and an important dimension of film narration. With the continuous reshaping of the understanding of space by film artists, film space plays an important role in film narration.

The artistic combination of space and modeling decoration of suspense films is a sign that the language of film

texts is gradually modernizing, and it is also the requirement of film art itself. The significance of this research is that it can be not only a measure of whether movies meet the psychological expectations and aesthetic standards of people watching movies in contemporary consumer society but also the key to the success of market strategy and operation mode. Based on MV (machine vision), this paper combines the concept of suspense movie space with modeling design, analyzes suspense movie scenes and semantics, abstracts and summarizes the expression forms of movie scene space design, and seeks its expression methods to make it more systematic. Relatively speaking, it is a brand-new perspective and a meaningful attempt.

2. Related Work

2.1. Research on Film Space Modeling Design. The reality in movies has always been constructed with a purpose by writers and directors. Writers construct a story full of suspense with their strict logic and distribute suspense points in every corner of the story so that the audience can find their way into the vortex of the story. The task of space modeling is to design a unique space form according to the script so that the actors can feel the emotions needed by the story in the space.

Lefkowitz made full use of logical analysis in concrete analysis and finally analyzed and discussed the characteristics and skills of suspense movies in confined space in detail through the analysis of movies [4]. Haworth, starting from the film itself, tries to explore the essential relationship between film and space. In the two fields of film theory and film production in practice, the “homogeneity” of film editing and space is affirmed [5]. Paul analyzes the aesthetic culture of display art in the performance of film and television creation, discusses the expression ways and the following principles of display art in movie scenes, and puts forward a series of problems like scene props and display should conform to the development of the plot, paying attention to the historical context, and so on, which have higher requirements for surrealist movies in space presentation [6]. Taking surrealist movies as the research object, the author makes a comparison between their spatial presentation characteristics and other movie spaces so as to explore the spiritual core of surrealist movies. Miranda and Wanderley proposed that interior furnishings should exist as art in movies and its aesthetic culture is reflected by props and furnishings. These designs should not only serve the plot but also reflect its artistic value [7].

2.2. MV Correlation Research. MV technology is a modern measurement technology based on optical measurement and compound digitalization in photoelectric measurement system. In the process of MV perception, it is necessary to accurately identify human behavior so as to provide data support for machine intelligence services [8]. Therefore, the method of human behavior recognition in MV perception has become a hot topic in the field of MV [9].

Ye et al. in the field of remote sensing surveying and mapping, the Institute of Electronics, Chinese Academy of

Sciences, studied the method of remote sensing image target recognition based on deep learning and improved the accuracy and efficiency of target recognition [10]. Nandi et al. proposed an MV device and method for can inspection [11]. This method proposed an entropy clustering algorithm combined with prior shape constraints to locate the can and divide the area. Multiscale detection algorithm was introduced to look for defects along the projected contour, and the accuracy of defect detection for round cans with this method reached 99.48%. Dawood et al. put forward an MV system for orchard navigation [12]. This system captures the crown and background sky of fruit trees in the orchard in real time through a multispectral camera and provides unmanned vehicles on the ground with the characteristics of the central row of trees that can be used for autonomous navigation. Experimental results show that this system can achieve autonomous navigation in peach orchards. Amraei et al. designed an identification method of broken blade in edge profile milling machine based on MV [13]. In this paper, it was pointed out that, by positioning the blade screw, the expected position and direction of the blade were determined by geometric operation, and the deviation from the expected blade to the actual edge of the blade was calculated to determine whether the blade was damaged or not.

Yang et al. proposed the face detection method based on AdaBoost. Up to now, the object detection algorithm has gone from the traditional architecture of artificial design features combined with a shallow classifier to the EndToEnd object detection architecture based on big data and deep neural network, and the object recognition technology has gradually matured [14]. The automatic apple sorting and quality inspection system designed by Dema et al. integrates image processing and curve-fitting software, which makes the accuracy rate of the sorting process approach 96% [15]. Sun et al. put forward a dense segmentation method based on texture and a fruit detection method based on shape to calculate the MV algorithm of mango trees [16]. This method can accurately segment and detect the fruit in the crown image and can quickly and accurately predict the fruit yield on the spot.

3. Research Method

3.1. Creation of Suspense Movie Space Form. Movie space refers to the basic space world embodied on the screen, which mainly includes two basic methods: the first is to reproduce the space, that is, to copy the real scene or the freehand scene realistically. The second is to create space, that is, by dispersing a series of montages of individual scenes together to form a unified and complete scene, emphasizing the creative function of montage.

There are three kinds of narrative focus in movies: zero focus, internal focus, and external focus. In the internal focus, the narrator only tells the audience what he knows from his own point of view, and the audience gets as much information as the characters. When choosing the camera position, how to control the viewpoint is the decisive factor, and the flow change of viewpoint usually appears in feature films. The viewpoint can quickly transition from this role to

the role and remain objective and neutral. Through this limited space, the suspense is more intense and intuitive. The creators of suspense movies constantly create conflicts and suspense, thus enhancing the drama of the story, impacting the audience's vision and thoughts, and then expressing the main idea and viewpoint of the story more deeply.

In the process of understanding and thinking, we gradually found that thinking dialectically from both sides is easier to grasp the key of the problem and obtain more ideal and scientific cognitive effect than simply looking at the problem from one angle. Make the original static objects vivid and the isolated objects vivid so that the objects or concepts to be expressed are more intriguing and the public can get a more perfect and clear interpretation of the cognitive goals.

Therefore, for the scene space of suspense films, in order to highlight the communication of rhetorical images and spirituality, it focuses on the deformation of physical properties of spatial form and the change of vital signs, trying to create a distorted, weird, and absurd visual image, and making use of the abnormal and irrational spatial features to establish a closer connection with the potential consciousness and spiritual demands of characters.

When an object is photographed by a camera, the light reflected by the object is transmitted to a CCD (Charge Coupled Device) through the camera lens. After the CCD is exposed, the light information of the measured object forms an optical image on the photosensitive surface through the optical system, and at the same time, the charge is excited on the photosensitive element. If camera distortion is not considered, the camera linear model is pinhole model [17].

According to the principle of pinhole imaging, it is assumed that the size of the measured object is Y , the image height is y , the distance between the object and the center of the lens (object distance) is L , the focal length of the lens is f , the distance between adjacent pixels is d , and the number of pixels occupied by the image height is N ; namely, $y = Nd$. From the lens imaging formula, we can get

$$Y = \left(\frac{L}{f} - 1 \right) Nd. \quad (1)$$

The measurement process includes optical imaging, image signal output, binary processing to determine the figure outline, measuring the number of pixels between the outlines, and calculating the measured parameters according to the measurement formula [18].

If the positioning area of each anchor node is a hollow sphere with thickness 2ε , the positioning area of the unknown node is the intersection A_p of four anchor node positioning areas.

When ε is not large, the composition surface of A_p can be regarded as a plane, the four groups of opposites of A_p must be parallel planes with a distance of 2ε , and A_p must have an inscribed sphere R with a radius of ε :

$$R = \{(x, y, z) \mid x^2 + y^2 + z^2 = \varepsilon^2\}. \quad (2)$$

When the number of anchor nodes increases, there are more and more sections of A_p , and A_p approaches R more and more. The smaller R is, the smaller the location area of

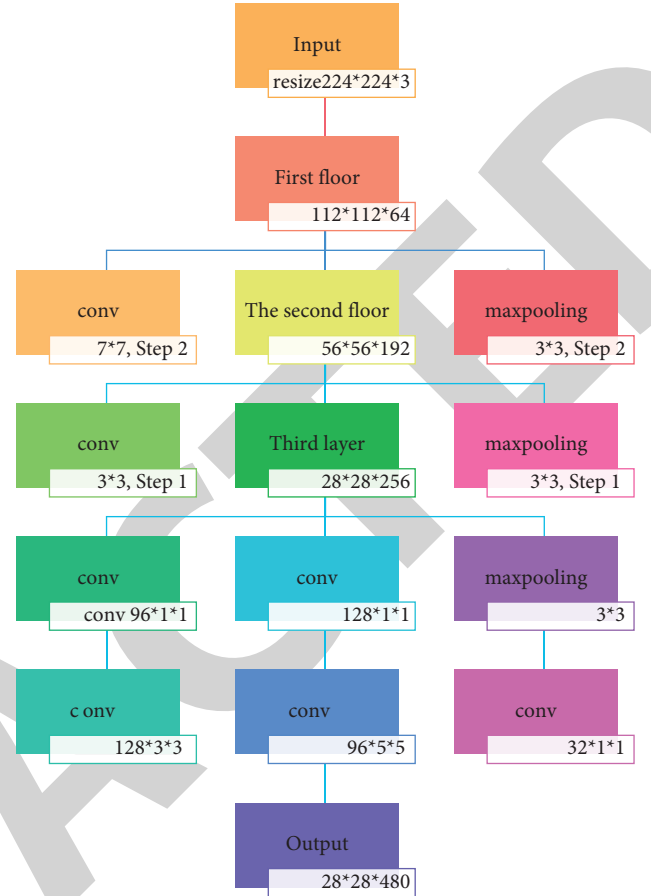


FIGURE 1: Model operation flowchart.

unknown nodes is and the higher the location accuracy is; then R is the absolute error area of unknown nodes.

This section mainly introduces the image classification method based on CNN (Convective Neural Network). Combined with the demand for suspense movies, this paper chooses a CNN model with simple system construction, high accuracy, short prediction time, and wide application range [19]. CNN belongs to the category of neural network and is a classic and widely used structure in the field of deep learning technology.

The idea of AlexNET applies the basic principles of CNN to a deep and wide network, which makes the values of local neurons with larger responses become larger, suppresses other neurons with smaller feedback, and enhances the generalization ability of the model.

Net introduces the Inception structure (integrating feature information of different scales) and adopts a parallel structure. The high dimension and wide dimension of the feature matrix obtained by each branch must be the same. The running flowchart of Google's first three layers model is as follows (Figure 1).

Features that are useful in one area may be applicable in another area. Therefore, in order to describe a larger image, the maximum value of a specific feature on the image can be calculated to represent the features of this area, and the maximum pool can retain more texture information [20].

The ReLU activation function formula is as follows:

$$f(x) = \max(0, x). \quad (3)$$

ReLU function has the following advantages: unilateral inhibition, relatively wide excitation boundary, and sparse activation, so it is the most widely used activation function.

The essence of 3D reconstruction refers to the establishment of appropriate computer expression and mathematical model for 3D objects. That is, it can be understood that, by inputting data formats that can be understood by the computer, these input data are converted into three-dimensional images of objects displayed on the computer screen through the inherent three-dimensional reconstruction algorithm. For the 3D reconstruction algorithm, the reconstruction process includes data acquisition, preprocessing, point cloud registration, and triangulation. Among them, point cloud registration is the key point in the process of 3D reconstruction, and the result of point cloud registration directly affects the accuracy and authenticity of the final 3D reconstruction model.

Because the computer cannot know the scale of the object contained in the image to be processed in advance, it is necessary to sample the image at multiple scales and get the best scale of the object of interest from these sample images. The scale space of an image is the description of the image at all scales. The scale space of an image can be symbolically expressed as an image pyramid.

When the matching point between the target point cloud and the reference point cloud is known, ICP (Iterative Closest Point) algorithm can be described as follows.

Suppose there is a reference point cloud point set P , and its matching point set corresponding to the target point cloud is Q . Then, the process of aligning and registering the reference point cloud to the target point cloud can be understood as minimizing the value of

$$f(R, t) = \sum_{i=1}^N \|Q_i - (RP_i + T)\|^2. \quad (4)$$

Equation (4) is the objective function in point cloud registration. The so-called optimal transformation matrix for point cloud registration is the process of making the objective function value converge to the minimum.

The essence of the ICP algorithm is to solve the rotation matrix R and translation vector t between the reference point set P_i and the target point set Q_i , so as to minimize the objective function. For how to use matching points to solve the optimal transformation matrix, the ICP algorithm can iteratively minimize to the optimal solution.

Then, for the objective function, it can be simplified into the form as shown in

$$\sum_{i=1}^2 = \sum_{i=1}^N \|q'_i - Rq_i\|^2. \quad (5)$$

The concept of triangulation of curved surface point cloud is to divide the points in space into triangular planes according to the triangulation algorithm for discrete point

cloud data in space and finally make the point cloud from a complete triangular mesh.

3.2. Film Space Color Design. Reality and fantasy are two common narrative elements in suspense movies. Even if what is displayed in the image is unrealistic or surreal space, all this needs realistic space to carry the narrative scenery. On the basis of objective reality, enlarge or reduce the image features of the spatial elements, create novel and surprising visual effects, have a strong visual impact on viewers, and enhance the expressive force and appeal of the spatial theme.

Only when color is used in specific situations can it better express its authenticity. Such situations are based on the category of movies and the meaning of color. Some film workers make full use of color to create the atmosphere of the film so as to express the deep connotation of the film. At the same time, for film and television creators, it is also a way of film and television processing and creation so as to enhance the connotation of the film.

The spatial structure of a certain picture in the movie has a strong interpretation of the spiritual connotation, which leaves a deep impression on the audience. When it is in a certain picture background, it is associated with the background, creating contrast and conveying the spirit of the movie. When creating a movie space, artists often use different colors to express their emotions and endow the movie with personal thoughts and souls.

In suspense films and television works, closed color images, such as black and white and dark blue, which are dull and gloomy, can bring people feelings of depression and sadness and can arouse people's reflection on social reality and moral introspection. In confined space movies, the use of color has certain characteristics. This kind of movie often uses closed colors, that is, inactive colors, such as blue, black, and white, which bring people into sad scenes, and being in such an environment makes the audience reflect on themselves and other things.

It can experience deeper emotional significance and spiritual touch while experiencing shock and arousing thinking. For the audience, the audience's sight is framed in a fixed space scene, and all contradictions and conflicts should be concentrated in this narrow space so that the presentation of a temporarily closed space can better show the dramatic effect of the film.

The algorithm adopted in this paper is to analyze and process each component in different color spaces reasonably and effectively on the basis of the existing theory and adjust it with the corresponding contrast adjustment function. After the adjustment, the layering of the image is not obvious, and the details in the dark place are blurred. Therefore, the dynamic range adjustment in RGB space is further made to make the details of the image clear. The whole processing flow is shown in Figure 2.

There are two types of human retina: cone-shaped cells and rod-shaped cells, among which cone-shaped cells are mainly sensitive to color, rod-shaped cells are more sensitive

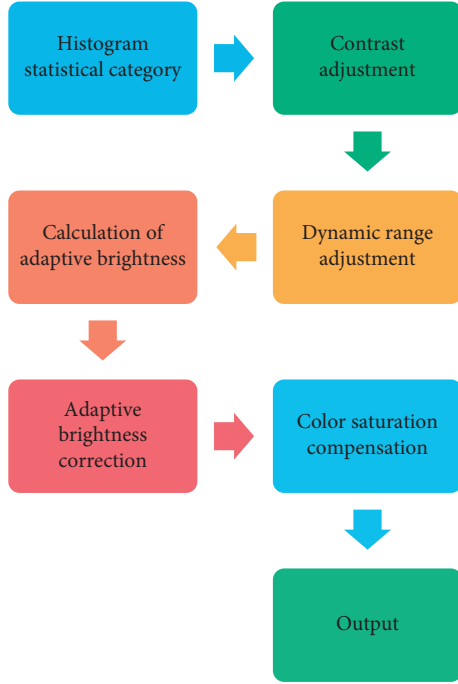


FIGURE 2: Algorithm processing flow.

to intensity, and the change of intensity is nonlinear. The human eye's response to the input receptor is expressed by MTF (Modulation Transfer Function). A basic MTF model is as follows:

$$I_0(x, y) = K_1 \lg[K_2 + K_3 I_i(x, y)], \quad (6)$$

where K_i is a constant, $I_i(x, y)$ is an input, and $I_0(x, y)$ is an output.

The concept of linear system can be applied to human visual system, and the MTF function can be inversely transformed to obtain a new function so that the MTF after passing through the human eye has an approximate linear effect, which can be called linear correction function. The formula is as follows:

$$I_{\text{out}}(x, y) = \frac{K_1}{K_2 + e^{K_3(K_4 - I_{\text{in}}(x, y))}}, \quad (7)$$

where K_i is a constant, K_1, K_2 are normalization constants, K_3 is a parameter for adjusting the contrast of the image, and K_4 is used for adjusting the brightness of the image. $I_{\text{in}}(x, y)$ is the input signal, and $I_{\text{out}}(x, y)$ is the output signal.

Considering the amount of calculation and personal preference for color vividness, the exponential stretching method is mainly used in the experiment; namely,

$$\begin{aligned} S &= \sqrt{a^2 + b^2}, \\ \bar{S} &= S^a, \end{aligned} \quad (8)$$

where S is the original saturation component, \bar{S} is the transformed harmony component, and a is the stretching factor, which determines the saturation degree of the saturation component.

In the color space, the brightness information is counted by histogram. According to the histogram information, the image is judged as dark, normal, or bright, and then different adjustment functions are adopted to adjust it according to different situations.

$$\begin{cases} \text{partial darkness,} & \frac{N_1 > (M \times N)}{2}, \\ \text{normal,} & \frac{N_2 > (M \times N)}{2}, \\ \text{pianliang,} & \frac{N_3 > (M \times N)}{2}, \\ \text{no treatment,} & \text{other,} \end{cases} \quad (9)$$

where N_1, N_2 , and N_3 are the number of pixel values falling in dark, normal, and bright areas, respectively. In this paper, the appropriate threshold is selected through many experiments to divide these three situations.

When the dynamic range is too large, because the brightness change range that can be distinguished by human eyes is limited, the signal in the dark area is often covered by the signal in the high gray value area, which affects the performance effect of the target area and makes it difficult to identify the details of the dark area [11].

By analyzing the characteristics of each component of an image in various color spaces, we can skillfully use the function characteristics of power function in the range of $[0, 1]$. And the brightness of the input image is adaptively corrected to different degrees by using the commonness of the brightness components of the image.

4. Result Analysis

In the process of film shooting, a space is repeatedly used for shooting, and many storylines and character relationships are closely related to a fixed location. Suspense film is a type of film that uses intricate narrative methods and plots to create suspense. This kind of film will make the audience feel nervous, so they can follow the plot full of doubts in the film to think and find the answers to suspense events. The reconstruction and artistic expression of the visual elements of the material space in the film originated from the film-makers' understanding and cognition of the design composition of the real interior space design, and then it can present an intuitive and sensible physical image, as well as a beautiful and exquisite visual feeling. More importantly, the artistic space itself has a relatively independent aesthetic meaning and cultural value in the whole suspense film text "context."

In order to verify the effectiveness of this algorithm, an experiment is needed. During the experiment, it is necessary to establish the MV perception simulation environment first. During the experiment, the behaviors of human body in four situations, such as walking, squatting, sitting, and bending, are selected, and the three-dimensional human behavior recognition algorithm proposed in this paper is used to

TABLE 1: Algorithm recognition result.

| | Walk | Squat down | Sit | Bend down | Discrimination (%) |
|------------------------------|------|------------|-----|-----------|--------------------|
| Walk | 9 | 1 | 0 | 0 | 90 |
| Squat down | 0 | 10 | 0 | 0 | 100 |
| Sit | 0 | 0 | 9 | 1 | 90 |
| Bend down | 0 | 0 | 0 | 10 | 100 |
| Average recognition rate (%) | 95% | | | | |

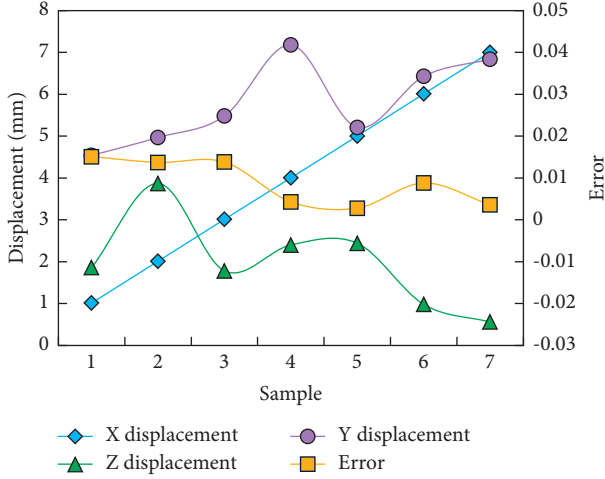


FIGURE 3: Measurement results of moving x-axis static test.

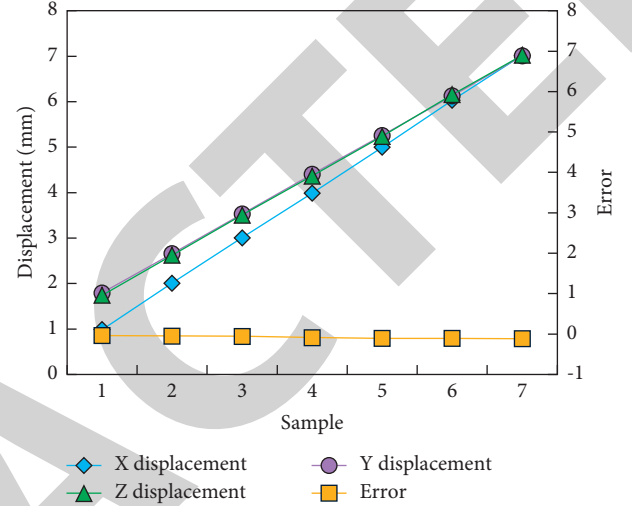


FIGURE 4: Measurement results of XYZ triaxial static test.

recognize them. The contour area of the initial image of human behavior is detected.

Extracting the three-dimensional feature components of the image in the target contour area can complete the three-dimensional human behavior recognition in MV perception. According to the method described above, the obtained recognition results can be described in Table 1.

It can be known that the average recognition rate of human behavior in MV perception using this algorithm is 95%, which can effectively improve the recognition accuracy.

Install the target on the displacement test bed, two cameras shoot and record the reference image of the initial position of the target, open the displacement test bed, then shoot and record the working condition image of the target's motion state, set different maximum displacements of the target along the three-dimensional direction, do five groups of experiments in total, each group records 10 images, and close the displacement test bed. The results are shown in Figures 3 and 4.

It can be seen that the relative error decreases with the increase of x -axis displacement. With the movement in the x -axis direction, the displacement changes in the y -axis and z -axis directions also appear, which is caused by the mathematical model and the algorithm itself, but the calculation results caused by this addition are all small. The maximum absolute error in the x -axis direction is less than 0.0147 mm, and the maximum relative error is less than 1.36%.

In the movement process of the platform, besides the movement in the y -axis direction, it will also lead to the movement in other coordinate axes. In this additional

movement, the rotation angle around the y -axis is slightly larger, while the rotation angles around the x - and z -axes are both smaller. It shows that when the platform vibrates along the y -axis, a slightly larger rotation angle around the y -axis will be introduced. When the linear displacement platform vibrates, the vibration direction of the rotating rod and the geometric center of the platform cannot be completely coincident, so the platform will slightly swing relative to the rotating rod.

Suspense movies are often related to dark events such as crime and murder, and the setting of characters is also biased towards social marginalization, mainly inclined to the characters wandering in the black and white fringe, such as thieves, killers, and groups at the bottom of social groups. Through the blank space outside the painting, the audience's imagination can be stimulated, the space of the whole film can be expanded, the information and content of the film can be enriched, and the audience can actively anticipate what will happen outside through imagination, thus increasing the blank space and charm of the whole film and making the audience perfect the whole film through imagination. This section uses a variety of models to identify different scenes of suspense movies with the same learning rate setting. The identification results are shown in Table 2.

As can be seen from Table 2, the test accuracy of the AlexNet model is the lowest, the test accuracy of the VGG16 model is similar to that of GoogLeNet, the accuracy and loss function value of the training set are both good, both verification set and test set are optimal, and the weight model is in a moderate fitting state.

TABLE 2: Comparison of different model results.

| Method | Iterations | Training loss function | Training accuracy | Verification loss function | Verification accuracy | Test accuracy |
|-----------|------------|------------------------|-------------------|----------------------------|-----------------------|---------------|
| AlexNet | 81 | 0.014 | 1 | 0.214 | 0.916 | 88.014 |
| VGG16 | 66 | 0.023 | 0.986 | 0.003 | 1 | 96.327 |
| GoogLeNet | 46 | 0.016 | 0.991 | 0.007 | 0.998 | 99.869 |

In the artistic creation of suspense films, the director often uses the means of overprinting to establish a close connection among the spaces of the same picture so that it reflects the subjective ideological motivation, so as to create a kind of multijuxtaposition visual effect with a special meaning. Animal horns, specimens, and so on all reveal a horror element, which satisfies the audience's image acceptance of horror psychology. In addition, most of the images are gray-white to frame the narrative picture of the images. The depressing color of this picture makes the audience unable to escape the intense and exciting plot induction, thus truly deriving the fear from the psychology and then making the horror meaning of the images more artistic and emotional.

In order to verify that the proposed 3D reconstruction algorithm improves the traditional algorithm, the strategy design pattern is adopted in the point cloud data registration module of the 3D reconstruction system designed in this paper. In the reconstruction of objects, the three-dimensional reconstruction algorithm in this paper and the traditional ICP registration reconstruction algorithm are used, respectively, and the reconstruction efficiency of the two algorithms is compared. The comparison between this algorithm and the traditional algorithm is shown in Figure 5.

It can be seen that, compared with the traditional reconstruction algorithm based on ICP registration, this algorithm introduces the method of image feature point detection into the rough registration stage of point cloud registration and realizes the dimension reduction of rough registration. At the same time, the idea of space bounding box is introduced to limit the search space, thus improving the search efficiency of matching points. Compared with the traditional reconstruction methods, this paper has improved the overall object reconstruction efficiency.

At the same time, this paper combines the RGB value of point cloud and the distance between points as the feature measurement method of accurate registration. Compared with the traditional feature measurement method based only on the distance between points in ICP registration, the accuracy of point cloud registration has been further improved.

In order to verify the applicability of the algorithm, a variety of scenarios are selected for experiments. Applying the direct gray-scale image enhancement algorithm to the brightness component of a color image while keeping the other two components unchanged can play a certain role, making the details of the image clearer, but ignoring the color information of the color image makes the image appear monotonous. Figures 6 and 7 show the experimental results of various scenarios.

By analyzing the brightness histogram information of the input image for discrimination and classification and making full use of the color space to skillfully process each component, the video image quality can be enhanced

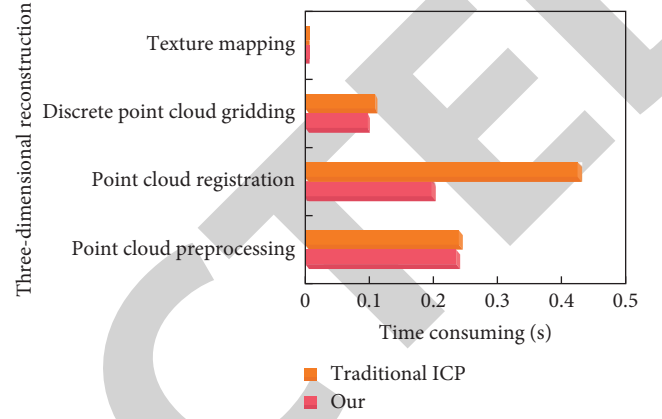


FIGURE 5: Algorithm comparison.

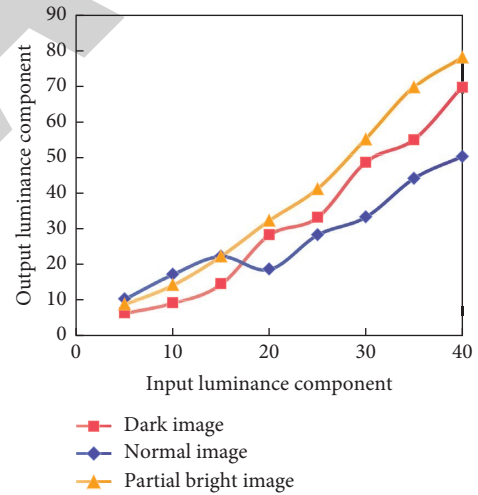


FIGURE 6: Classification contrast adjustment.

adaptively. While the contrast is enhanced, the details of the original image are kept as much as possible through dynamic range adjustment, which avoids the negative impact of traditional contrast enhancement methods.

Under the commercial operation mode, the design of the scene reflects the separation and grafting of time and space, which promotes the scene design to incorporate reasonable, fashionable, and popular urban elements to meet the setting and narrative functions of the images and also caters to the aesthetic needs of the market economy. The perfect display of the rhetoric meaning of spirit and culture is the manifestation of the broader implication and temperament of film art. Compared with full-length play, the one-act drama changes faster, and its climax is more direct. Because of its short time, the one-act drama has to give the audience

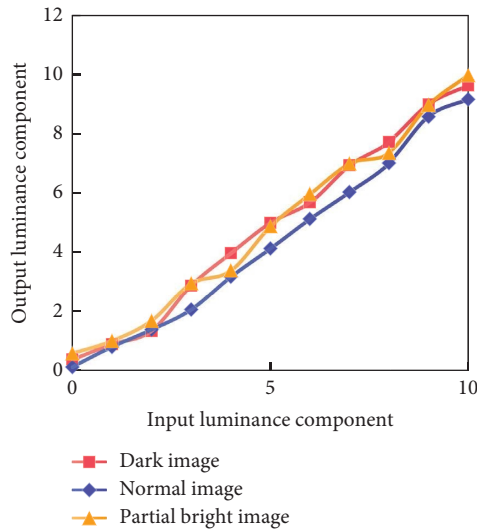


FIGURE 7: Adaptive brightness correction.

conflicts in a very short time, and its climax is fast, giving people a more direct visual feeling and sensory stimulation.

Suspense movies have to make a lot of efforts in audio-visual language and have their own unique skills. With the help of the characteristics of expressionism, the materials in the distorted dark world are used, and the colors are dim. Cool colors create a suspenseful atmosphere. The most important, valuable, and convincing thing in any artistic work is the author's personal attitude toward life, which is what he describes in his works based on this attitude. The value of an artistic work lies not in the unity of conception or anything else but also in the distinctiveness and firmness of the attitude of the author towards life that runs through the whole work.

5. Conclusion

Suspense movies are often characterized by high tension, excitement, strong expectation, and uncertainty and attach great importance to the inherent interaction and participation between movies and movie audiences. The modeling design of the scene space is also constantly being innovated and expected. With the increasing development of digital technology, film creators have begun to try to innovate the modeling of the scene space by using new technologies and different ideographic ways. This paper presents a 3D human behavior recognition algorithm in MV perception. Making full use of the color space to skillfully process each component can adaptively enhance the image quality of the video image. Avoiding the color loss of the image can make the processed image clear, colorful, and layered, thus achieving the purpose of improving the video quality. The experimental results show that this algorithm can accurately identify the human behavior and greatly improve the accuracy of human behavior recognition.

Data Availability

Data are available on request to the author.

Conflicts of Interest

The author declares no conflicts of interest.

References

- [1] S. Marsen, "The semiotic construction of worldview in film: multimodal variations in le Samourai, the killer, and ghost dog," *Semiotica*, vol. 2012, no. 190, pp. 153–175, 2012.
- [2] G. G. Mun, "The background of 'Young Sang Shi Dae' in Korean film history and the historical significance," *Cineforum*, vol. 14, pp. 359–388, 2012.
- [3] M. Sinka, "German film studies nostalgia after Nazism: history, home, and affect in German and Austrian literature and film by Heidi Schlipphacke," *German Quarterly*, vol. 85, no. 1, pp. 99–101, 2012.
- [4] D. Lefkowitz, "A D centered approach to sound and meaning in spike Lee's Chi r," *Journal of Linguistic Anthropology*, vol. 29, no. 2, pp. 231–238, 2019.
- [5] C. Haworth, "Seeing through Music: Gender and Modernism in Classic Hollywood Film Scores. By Peter Franklin," *Music and Letters*, vol. 94, no. 2, pp. 365–367, 2013.
- [6] B. Paul, "Entomology as anthropology in the films of luis buñuel," *Screen*, vol. 48, no. 4, pp. 425–442, 2007.
- [7] L. V. E. R. Miranda and M. M. Wanderley, "New digital musical instruments: control and interaction beyond the keyboard," *Computer Music Journal*, vol. 31, no. 4, pp. 75–77, 2014.
- [8] W. S. Qureshi, A. Payne, K. B. Walsh, R. Linker, O. Cohen, and M. N. Dailey, "Machine vision for counting fruit on mango tree canopies," *Precision Agriculture*, vol. 17, no. 3, pp. 1–21, 2016.
- [9] A. Nasirahmadi, S. A. Edwards, and B. Sturm, "Implementation of machine vision for detecting behaviour of cattle and pigs," *Livestock Science*, vol. 202, pp. 25–38, 2017.
- [10] X. W. Ye, C. Z. Dong, and T. Liu, "A review of machine vision-based structural health monitoring: methodologies and applications," *Journal of Sensors*, vol. 2016, no. 5, pp. 1–10, 2016.
- [11] C. S. Nandi, B. Tudu, and C. Koley, "A machine vision technique for grading of harvested mangoes based on maturity and quality," *IEEE Sensors Journal*, vol. 16, no. 16, p. 1, 2016.
- [12] T. Dawood, Z. Zhu, and T. Zayed, "Machine vision-based model for spalling detection and quantification in subway networks," *Automation in Construction*, vol. 81, no. sep, pp. 149–160, 2017.
- [13] S. Amraei, S. Abdanan Mehdizadeh, and S. Salari, "Broiler weight estimation based on machine vision and artificial neural network," *British Poultry Science*, vol. 58, no. 2, pp. 200–205, 2017.
- [14] A. Yang, X. Gao, and M. Li, "Design of apochromatic lens with large field and high definition for machine vision," *Applied Optics*, vol. 55, no. 22, Article ID 5977, 2016.
- [15] M. Dema, C. Turner, H. Sari-Sarraf, and E. Hequet, "Machine vision system for characterizing horizontal wicking and drying using an infrared camera," *IEEE Transactions on Industrial Informatics*, vol. 12, no. 2, pp. 493–502, 2016.
- [16] T.-H. Sun, F.-C. Tien, F.-C. Tien, and R.-J. Kuo, "Automated thermal fuse inspection using machine vision and artificial neural networks," *Journal of Intelligent Manufacturing*, vol. 27, no. 3, pp. 639–651, 2016.
- [17] Y. Ding, X. Zhang, and R. Kovacevic, "A laser-based machine vision measurement system for laser forming," *Measurement*, vol. 82, pp. 345–354, 2016.

Retraction

Retracted: Analysis of the Effect of Video-Guided Dance Creation for Young Children

Mobile Information Systems

Received 26 September 2023; Accepted 26 September 2023; Published 27 September 2023

Copyright © 2023 Mobile Information Systems. 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. Qin, T. Huang, and G. Tang, "Analysis of the Effect of Video-Guided Dance Creation for Young Children," *Mobile Information Systems*, vol. 2022, Article ID 1110698, 8 pages, 2022.

Research Article

Analysis of the Effect of Video-Guided Dance Creation for Young Children

Yanan Qin ¹, Tao Huang,² and Guanzhen Tang³

¹Preschool Education, Xi'an University, Xi'an 710065, Shanxi, China

²School of Information Science, National University of Defense Technology, Changsha 410015, Hunan, China

³College of Art, Yuncheng University, Yuncheng No. 44011, Shanxi, China

Correspondence should be addressed to Yanan Qin; qinyannan@xawl.edu.cn

Received 2 May 2022; Revised 14 May 2022; Accepted 26 May 2022; Published 16 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Yanan Qin 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.

Children's dance is an important part of quality education for children, and it is also an important channel for children's physical and mental development. Traditional children's dance education adheres to the teaching method taught by teachers, and teachers insist on teaching progress. In order to improve the level and quality of children's dance creation, this paper analyzes the effect of children's dance creation under video guidance and discusses the integration strategies in children's dance creation. Children's dance education in the video teaching environment advocates the combination of online and offline teaching characteristics, and it is necessary to pay attention to the subjective initiative of students. At the same time, how to effectively use video teaching to improve aesthetic ability, effectively summarize online and offline resources to enhance educational efficiency, and make arrangements to strengthen the network. The quality of video-guided dance teaching is an era subject for the development of video-guided learning. Children's dance education in the video teaching environment needs to focus on the development of teaching forms and the transformation of teaching thinking ability and guide students to strengthen their aesthetic ability in practical activities and teaching methods.

1. Introduction

In the new situation of China's economic development, the quality of life of residents has been significantly improved, and more attention has been paid to early childhood education [1]. This is not only not in line with the social development trend but also not conducive to the overall development of children's physical and mental qualities. Therefore, teachers should cater to the personality characteristics of contemporary children and combine the requirements of quality education to carefully choreograph young children's dances, so as to lay a solid foundation for the improvement of young children's dance skills and comprehensive quality [2].

Dance refers to a performing art and a comprehensive dynamic modeling art. The dancer completes the relevant movements through the body, which can realize the dancer's self-worth and also reveal the artistic value of dance, as well as reflect the dancer's thoughts and feelings [3]. In the

process of young children's dance creation, more dance elements need to be incorporated, through the dance elements to stimulate the enthusiasm of young children to participate in the dance, and help young children to achieve their own development in the process of participation in the dance [4].

However, at the present stage, teachers teach children the dance mechanically and let them train one movement repeatedly but neglect to let them really devote themselves to the music to feel the emotion of each movement, so the movements expressed by children will mostly have a mechanical feeling. Some people may argue that children are too young to truly understand and perceive music, so how can they feel the emotions of each movement? However, young children are in the chaotic stage of the world, curious about everything in the world; in this process, the teacher needs to provide a channel for young children to perceive the world; here is an example of my actual teaching case: let the children close their eyes and listen to the sound of trickling

water, with the sound of the water; let the children's own body twist up with the music; this time the children themselves will slowly put their bodies or the children themselves slowly twisted their bodies or arms and did not wave their bodies and arms in a frenzied manner [5]. This proves that as long as teachers let children experience the emotions in the music from easy to complicated, children's experience of the music will allow them to get a sense of the music and dance movements themselves [6].

As the music plays, the children will also dance with their true feelings to dance out of the spirit of the dance. Another reason is to teach new ideas and concepts of dance teaching through traditional teaching methods [7]. When teaching the poem "Goose", the children could have felt better through the gesture dance, but in the end, they were allowed to follow the teacher's mechanical repetition of training gestures, forgetting the deeper meaning behind the use of dance teaching, making the lively and interesting dance teaching into mechanical repetition of imitation, and in the process of constantly overemphasizing skill training, the children would feel the dullness of mechanical repetition and thus lose is one of the most important aspects of the teaching process that makes the teacher put the cart before the horse [8–10]. It is of great value to promote the overall development of physical and mental qualities of young children, improve aesthetic ability, effectively summarize online and offline resources, improve educational efficiency, and network well. The quality of video-guided dance teaching is an epochal theme in the development of video-guided learning.

2. Related Work

As an important channel for young children to develop themselves and express themselves, dance education can help young children to form correct values and outlook on life, promote their healthy physical and mental development, cultivate their spiritual world, and have positive significance and important value for their future learning and development [11].

At this stage, the strategy of young children's dance creation mainly has the following categories: music and dance are inseparable and complete components; teachers in the young children's dance innovation choreography need to combine the psychological characteristics and personality preferences of contemporary young children, a reasonable choice of music material, the childlike, novel content, and music distinctive dance themes as the first choice, through reasonable choreography to enhance the art of dance. We should choose the music materials reasonably, take the childish, novel, and distinctive music as the first choice, enhance the fun of dance art through reasonable choreography, and stimulate children's enthusiasm and interest in learning dance [12]. First of all, dance is an important way for young children to perceive the society; teachers should try to choose some music with the atmosphere of life, so that dance can express the emotions of young children to life and close the distance between life and dance, so that young children feel the life of the art of dance; secondly, teachers also try to choose some of the currently popular, young

children like music, to stimulate them to learn. For example, the lyrics of the recently popular "The King Asked Me to Patrol the Mountain", which is rich in childish and childish fun, can bring children a better learning experience, and the integration of this childish fun into the dance can also enhance the fun of the dance and stimulate children's desire to perform; finally, the dance movements and background music are in line with the important principle of the teacher's choice of music, and only when the two are co-ordinated and complementary can enhance dance art of expression and ornamental power, therefore, teachers should combine the personality characteristics and age characteristics of young children and try to choose some music with a strong sense of rhythm and young children dance characteristics [13, 14].

The psychological characteristics of young children determine the form of young children's dance art; teachers create young children's dance, not only to highlight the artistry and ornamental dance works but also to play the value of dance creation to promote the physical and mental development of young children; therefore, teachers should cater to the psychological characteristics of contemporary young children for scientific creation [15]. First of all, teachers should combine the psychological needs of children of different ages to create dance, and the movements and music should meet the personality characteristics of children; secondly, teachers should analyze and explore the psychology of children, explore the artistic potential of children's dance, and take meeting the psychological needs of children as the important direction and basic principle of dance creation; finally, teachers should not ignore the educational role of children's dance, especially for children aged 5 to 6 years old [16]. In the dance teaching, teachers should pay attention to the integration of Chinese traditional culture as an important element of dance creation, which can not only play the literary and educational role of dance art but also help the balanced development of young children's physical and mental qualities, and promote the formation of positive and healthy thoughts and emotions of young children through dance learning.

2.1. Comprehensive Consideration of Young Children's Ability.

The purpose of dance creation is to play the nurturing value of dance art; therefore, teachers in the creation process, not from the perspective of adults to dance choreography, take into account the physical development of young children and dance ability, meet the psychological characteristics and physical characteristics of young children, and mobilize young children to actively participate in the dance learning [17]. First of all, teachers need to combine different children's dance foundations and comprehensive ability in dance choreography, to ensure that the dance movements are within children's ability, to avoid children's fear because of difficult dance movements, which is not conducive to their future dance learning; secondly, teachers should focus on guiding children to form the ability to express their emotions in the performance, to complete the sublimation of emotions through dance, and then play. Finally, the purpose

of dance creation is to lead young children into the sanctuary of art, prompting them to feel the charm of the art of dance; therefore, teachers should pay attention to the imagination of young children in the creation, through the creation of the mobilization of young children's imagination, so that young children pick out the artistic flavor of dance at the same time and get a good artistic experience, which will help young children's future artistic development [18–20].

3. Methods

Video instruction has had a significant impact on the traditional dance teaching model. The combination of video instruction technology and dance teaching mode and the practice of dance teaching gradually incorporates the logic of video instruction technology and gradually produces the “screenization” of performance space, the “fragmentation” of performance mode, and the “montage” of language framework “montageization”. Video instruction allows dance teaching to break through the constraints of time and space, as the development of the teaching situation changes and the development of the dance teaching mode. Dance teachers can create an accompanying dance teaching base for their students through the effective experimental fragmentation practice of video instruction technology. Based on the communication ability of video instruction technology, it is possible to combine various elements such as dance, voice, and image to create artistic scenes, thus improving the aesthetic ability of video instruction for teaching children's dance, increasing the relevant experience, and optimizing the video instruction system for teaching children [21–23].

From Figure 1, it can be seen that the children's dance routine is dominated by directional steps, which account for 45% of the dance routine, 34% of the dance routine with movement, and 21% of the dance routine with modeling. The children's dance routines are mainly created in the direction of change, which makes the children's dance performance more prominent, showing the colorful changes in different directions and giving the audience a different visual enjoyment.

The efficiency of traditional teaching is influenced by the teaching style, classroom atmosphere, and student acceptability. Based on the new media teaching mode to dance teaching activities, students can get more free time. From the students' point of view, based on their own actual situation, independent learning is carried out through the Internet, and students can freely choose audition resources, in which case the effect of teaching according to their abilities can be achieved. This open teaching mode allows students to be their own instructors, and the new media teaching mode requires a high level of independent learning skills.

From the teacher's point of view, the new demands made by video instruction require teachers to help students improve their learning methods and enhance their independent learning in their educational and teaching practices. In addition, teachers should help students to do extracurricular practice activities to improve their level of awareness and understanding of the beauty of dance. At the same time, according to the actual situation, the network punch card

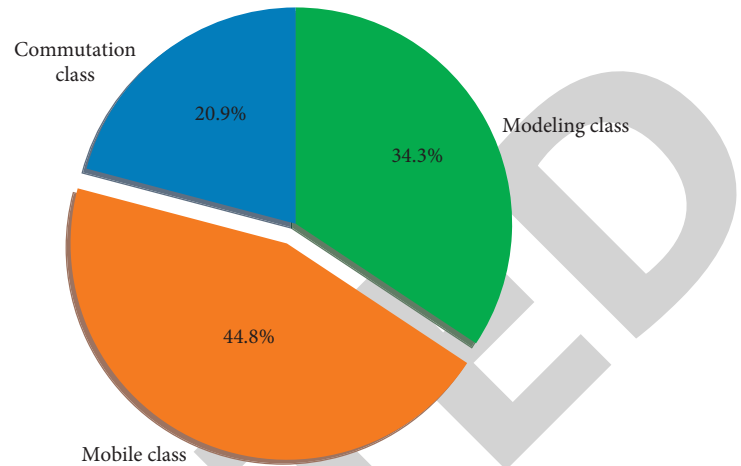


FIGURE 1: Diagram of the percentage of dance steps for children.

system can be built to establish a platform that enables teachers and students to interact and communicate, relying on the network to understand the actual situation of students, while students can also share their learning progress on the platform so that teachers can adjust the teaching progress and tasks in a timely manner [24–27].

It is generally believed that dance teaching in the traditional situation presents a vertical development, while children's dance teaching in the new context situation presents a horizontal development. Nowadays, with the continuous development of online dance programs and teaching videos, teachers can use various resources on the Internet to enrich students' learning content. In addition, because these videos are created with great care, they have strong ornamental and interesting features, which are very attractive to the children's group. By watching dance teaching videos, they can also subconsciously improve the aesthetic level of children and appreciate the charm of dance.

From Figure 2, it can be seen that the 2012 children's dance champion routine is dominated by directional steps, which account for 52% of the total, 30% of moving steps, and 18% of modeling steps. The contestant's competitive combination consisted of four main lines, namely, short, long, short, and long lines. The first short line started with a Spanish drag step followed by a connecting step, which was a moving series of dance steps, except for this dance step, and all the dance steps in this short line were of the direction change series; the second long line was mainly of the direction change series of dance steps, and two-thirds of the dance steps were connected with modeling steps and entered the direction change class; the third short line used all three types of dance steps; the fourth long line was mainly of the left-turn series of dance steps in the direction change class, and two-thirds of the dance steps were connected with modeling steps. The fourth long line is mainly a series of left-turn steps in the directional dance, and two-thirds of it is connected with the modeling steps.

Everything in the world has its own unique developmental rules, and dance movements are no exception. The creation of dance should be analyzed according to the origin

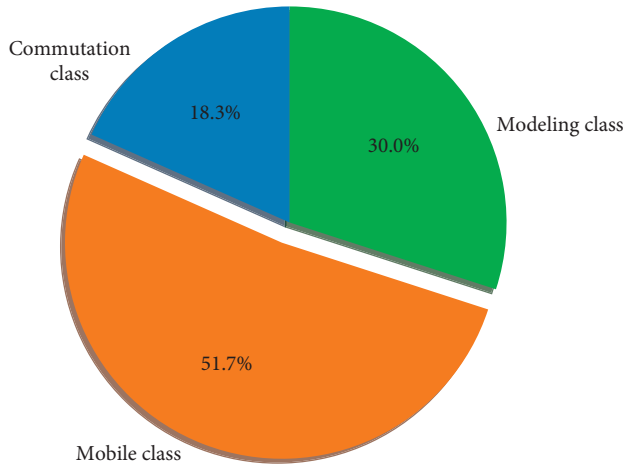


FIGURE 2: Diagram of the proportion of dance steps for children.

of each dance, the characteristics of the movements, and the characteristics of the music style used in each dance and follow its own regularity in choreography. A complete children's dance competition set from the beginning to the end is a combination of different movements plus connecting movements. In other words, if the children's dance routine is described in the form of a formula, it can be roughly divided into action *A* combination, connecting class action *B*, action *C*, action *D*, suitable for transition action *E*, and action *F* in series. Since children's dance competition routines are choreographed according to their choreography rules, there is a certain choreographic development trend; that is, there is a certain choreographic trend; see Figures 3 and 4.

The role of video instruction here is not only to create a good learning environment but also to provide students with excellent examples to follow. Video instruction changes the content of dance instruction from figurative to abstract. It makes the object of study in the arts more difficult to understand, yet it can expand the student's mind by removing the limitations of real life. Excellent learning examples can become teaching materials used by teachers in the teaching process. Using a video instruction system in dance classes also allows the video instruction to provide reference material for the classroom and improve teaching efficiency. It improves the liveliness and vitality of the classroom, attracts students' attention through video instruction, and increases students' interest in learning dance. Some experts and scholars say that teachers should integrate professional knowledge and textbook concepts, and to face some difficult knowledge points, they should borrow online resources to guide students to deepen their knowledge. When there are sufficient video instruction resources in the classroom, the education system will become more vivid and lively, and it can also stimulate classroom vitality and facilitate students' understanding of textbook knowledge. It can be said that in the current situation, video instruction is an important tool to liven up the classroom atmosphere. At the same time, different perceptual styles in terms of choreography design factors also bring many different effects, and the univariate

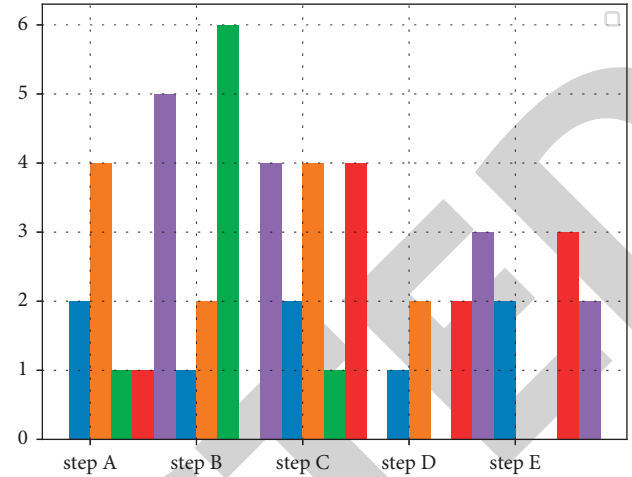


FIGURE 3: High-frequency combination dance steps.

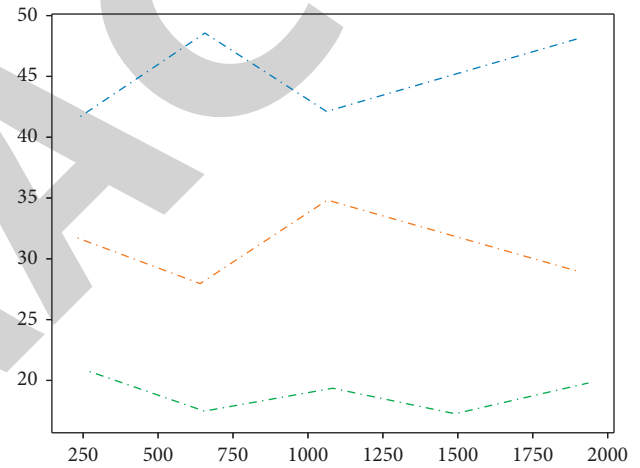


FIGURE 4: Trend of dance steps running style.

variance of teamwork ability scores of three perceptual learning style types is shown in Table 1.

In addition to time, video teaching is also associated with different spaces and subjects, making video teaching an extension of many elements such as subject and time and space. In the education and teaching of children's dance classes, students can communicate with teachers through video teaching, so as to get more targeted guidance and help. Teachers can also send artworks and teaching materials to students through video teaching, which is conducive to the formation of a better teaching effect, so as to cultivate students to form a higher aesthetic ability. The emergence of video teaching has greatly reduced the time and space constraints of dance education and teaching, making classroom teaching more diversified [28–30], and students' learning after class is also more convenient. In this way, the teaching activities take into account both extracurricular and classroom teaching, and students can better understand each key point and difficult action, which enriches the teaching process, thus forming a higher teaching quality. The one-way differences in the score of the director design are shown in Table 2.

TABLE 1: One-way variance f -analysis of teamwork scores for the three perceived learning styles.

| Type | N | Mean value (points) | Standard deviation | F | Value |
|--------------|-----|---------------------|--------------------|------|-------|
| Visual | 23 | 19.25 | 4.05 | 0.98 | 0.459 |
| Aural | 23 | 16.38 | 3.32 | | |
| Kinaesthetic | 23 | 18.16 | 4.12 | | |

TABLE 2: One-way variance f -analysis of choreography design scores for the three perceptual learning styles.

| Type | N | Mean value | Standard deviation | F | Value |
|--------------|-----|------------|--------------------|-------|-------|
| Visual | 23 | 14.58 | 1.45 | 0.688 | 0.049 |
| Aural | 23 | 12.55 | 1.65 | | |
| Kinaesthetic | 23 | 12.68 | 2.69 | | |

TABLE 3: Table of children's dance learning experience in the experimental and control groups.

| Classes | Total number of students | Have cheerleading learning experience (%) | No cheerleading experience |
|--------------------|--------------------------|---|----------------------------|
| Experimental group | 23 | 25.8 | (17) 77.5% |
| Control group | 23 | 29.9 | (16) 72.8% |

TABLE 4: Independent sample t -test analysis of the total scores of children's dance in the experimental and control classes.

| Classes | N | Mean value (points) | Standard deviation | F | Value |
|--------------------|-----|---------------------|--------------------|-------|-------|
| Experimental group | 23 | 56.39 | 6.55 | 2.545 | 0.035 |
| Control group | 23 | 49.82 | 2.65 | | |

4. Case Study

The integration of video instruction with children's dance instruction is similar to the traditional "teacher-student model" in that it allows the video teacher to play a variety of instrumental roles during the instructional period, which can be divided into several levels due to the different roles played by the video teacher. First, the recording of dance classes allows for supervision and control of dance instruction. This centralized control is mainly in the control of the number of times the content is displayed and the control of the duration of the video. Traditional dance instruction needs to be based on actual scenarios and is extremely dependent on specific temporal and spatial scenarios. Now, dance classroom people can become more intelligent and advanced through media to enrich the learning environment of dance. In the past, the teacher was the center of the classroom and the students were passive learners, often starting with themselves and instilling knowledge into the students based on their own understanding of what they know. But now, through media classes, students can actively acquire dance knowledge. They can also review knowledge based on their own weaknesses. More obviously, they can adapt their learning to the progress of different students, and video instruction can provide students with tools that help them go deeper. Students can use the mobile software to scrutinize dance moves, learn what they do not know about dance, and review in class based on their knowledge weaknesses.

In order to show that our instructional program is effective, we took an equal number of students from the experimental and control classes, both of 23 students, and the questionnaire mainly investigated whether the students have had experience in learning children's dance, as shown in Table 3.

The comparison between the experimental and the control group in the total score of children's dance after the experiment is shown in Table 4.

Table 5 shows the first impression of the beginning paragraph is very important. The beginning paragraph conveys the theme idea to be conveyed through body movements in the shortest time, giving the judges a strong feeling and a distinct impression.

Table 6 shows the middle paragraph is the most wonderful part of the set, and it is also the essential part, through which the theme idea will be fully reflected, and it is the supplement and continuation of the beginning paragraph.

The ending paragraph is the summary overview of the set, the further summary of the beginning paragraph and the middle, which can also be said to be the stage of the theme idea online, and the completion of the impression which makes the image more full and perfect; the end paragraph selection is shown in Table 7.

After the analysis of the beginning break, middle section, and ending section, we further compared the sets of movements of the teams in 2017 and 2018 to try to find the commonality of the best teams, and the comparison of the top six movement selections is shown in Table 8.

TABLE 5: 2017 action start paragraph selection.

| Ranking | Basic moves | Advanced moves | Self-programmed movements | Rotation movements | Modeling movements | Lifting movements | Subtotal |
|--------------------|-------------|----------------|---------------------------|--------------------|--------------------|-------------------|----------|
| 1 | 1 | 3 | 18 | 3 | 2 | 0 | 27 |
| 2 | 2 | 8 | 12 | 1 | 5 | 0 | 28 |
| 3 | 02 | 0 | 21 | 1 | 2 | 3 | 27 |
| 4 | 3 | 2 | 8 | 8 | 1 | 0 | 22 |
| 5 | 2 | 5 | 8 | 7 | 3 | 0 | 25 |
| 6 | 3 | 5 | 9 | 0 | 2 | 1 | 20 |
| Mean value | 2.55 | 3.98 | 12.39 | 3.65 | 2.28 | 0.68 | 25.53 |
| Standard deviation | 1.35 | 2.36 | 5.65 | 3.55 | 1.17 | 0.85 | 14.93 |

TABLE 6: 2017 action middle paragraph selection.

| Ranking | Basic moves | Advanced moves | Self-programmed movements | Rotation movements | Modeling movements | Lifting movements | Subtotal |
|--------------------|-------------|----------------|---------------------------|--------------------|--------------------|-------------------|----------|
| 1 | 9 | 36 | 47 | 25 | 25 | 3 | 145 |
| 2 | 8 | 35 | 52 | 28 | 28 | 0 | 151 |
| 3 | 7 | 55 | 40 | 22 | 22 | 1 | 147 |
| 4 | 5 | 50 | 47 | 11 | 10 | 2 | 125 |
| 5 | 6 | 57 | 33 | 10 | 12 | 0 | 118 |
| 6 | 7 | 79 | 25 | 9 | 8 | 1 | 129 |
| Mean value | 6.85 | 52.22 | 40.05 | 28.05 | 17.55 | 1.28 | 146 |
| Standard deviation | 2.35 | 14.65 | 10.55 | 2.15 | 8.28 | 1.17 | 39.15 |

TABLE 7: 2017 action end paragraph selection.

| Ranking | Basic moves | Advanced moves | Self-programmed movements | Rotation movements | Modeling movements | Lifting movements | Subtotal |
|--------------------|-------------|----------------|---------------------------|--------------------|--------------------|-------------------|----------|
| 1 | 1 | 0 | 2 | 3 | 4 | 2 | 12 |
| 2 | 0 | 1 | 5 | 1 | 2 | 1 | 10 |
| 3 | 0 | 0 | 13 | 0 | 1 | 1 | 15 |
| 4 | 1 | 1 | 12 | 0 | 0 | 0 | 14 |
| 5 | 0 | 0 | 11 | 3 | 2 | 2 | 18 |
| 6 | 0 | 0 | 21 | 0 | 1 | 0 | 22 |
| Mean value | 0.35 | 1.55 | 9.78 | 1.43 | 2.95 | 1.56 | 17.62 |
| Standard deviation | 0.49 | 2.68 | 5.69 | 1.45 | 0.72 | 1.77 | 12.8 |

TABLE 8: Comparison of the top six movement selections in 2017 and 2018.

| Year | Analysis | Basic moves | Advanced moves | Self-programmed movements | Rotation movements | Modeling movements | Lifting movements |
|------|--------------------|-------------|----------------|---------------------------|--------------------|--------------------|-------------------|
| 2017 | Mean | 9.25 | 58.22 | 63.11 | 33.25 | 22.55 | 3.28 |
| | Standard deviation | 1.98 | 13.02 | 7.75 | 2.55 | 8.99 | 2.46 |
| 2018 | Mean | 5.35 | 63.35 | 65.62 | 40.35 | 25.21 | 3.60 |
| | Standard deviation | 3.68 | 19.97 | 6.45 | 10.23 | 7.89 | 2.68 |

Table 9 shows the statistics of the top six choreographed sets of children's dance in 2017. We can see that the formation changes created in children's dance sets are of great importance.

The similarities between the 2017 and 2018 set selection are as follows: the use of linear formations is the most, the highest average of self-programmed movements in the same

year of the competition, and its mobility is high, followed by geometric formations, and the use of combination formations is the least. Combination formations were the least discrete in the same year of the competition. The variability is that the dispersion of linear formations was the highest in 2017 and the dispersion of combination formations was the highest in 2018. It can be seen that the top six in 2017 and

TABLE 9: Formation changes in 2017 sets.

| Ranking | Total number of changes | Change frequency mean value (s) | Line formation | Geometric formation | Combined formation |
|--------------------|-------------------------|---------------------------------|----------------|---------------------|--------------------|
| 1 | 43 | 8 | 23 | 14 | 5 |
| 2 | 36 | 7 | 28 | 12 | 6 |
| 3 | 53 | 9 | 27 | 12 | 12 |
| 4 | 28 | 8 | 26 | 13 | 4 |
| 5 | 26 | 10 | 19 | 11 | 6 |
| 6 | 54 | 6 | 35 | 8 | 10 |
| Mean value | 44.44 | 7.05 | 25.25 | 11.68 | 7.28 |
| Standard deviation | 6.82 | 1.09 | 5.20 | 2.02 | 3.35 |

TABLE 10: Changes in formation in the sets of 2017 and 2018.

| Year | Analysis | Change frequency mean value | Line formation | Geometric formation | Combined formation |
|------|--------------------|-----------------------------|----------------|---------------------|--------------------|
| 2017 | Mean | 7.15 | 25.22 | 11.65 | 7.19 |
| | Standard deviation | 1.23 | 5.02 | 2.01 | 3.26 |
| 2018 | Mean | 1.85 | 25.65 | 11.23 | 7.19 |
| | Standard deviation | 0.072 | 0.23 | 1.88 | 3.67 |

TABLE 11: Utilization of space in the 2017 sets ($N = \text{times}$).

| Ranking | A-ground | C-air |
|--------------------|----------|-------|
| 1 | 35 | 5 |
| 2 | 11 | 0 |
| 3 | 18 | 4 |
| 4 | 15 | 5 |
| 5 | 7 | 2 |
| 6 | 8 | 5 |
| Mean value | 16.02 | 3.45 |
| Standard deviation | 9.58 | 2.01 |

TABLE 12: Space utilization in sets in 2017 and 2018.

| Year | Analysis | Ground | Air |
|------|--------------------|--------|------|
| 2017 | Mean | 16.55 | 3.35 |
| | Standard deviation | 9.67 | 2.01 |
| 2018 | Mean | 16.22 | 3.44 |
| | Standard deviation | 3.27 | 2.65 |

2018 focused on highlighting the fluidity and stability of the sets when creating them; the shortcomings are the less innovative formations and too many repetitive formations. The specific comparison can be seen in Table 10.

And Table 11 shows the utilization of spatial scheduling in the top six sets of 2017, analyzed and compared according to the degree of dispersion to summarize the variability.

The average ground and air utilization in 2018 is slightly higher than in 2017, the discrete degree of ground in 2017 is greater than in 2018, while the discrete degree of air is lower than in 2018, and the space utilization in the set is shown in Table 12.

5. Conclusion

To sum up, under the new situation of educational development in my country, teachers should recognize the

importance and positive significance of dance creation, take effective measures to create dance based on the psychological and physical characteristics of contemporary children, and mobilize children to participate in dance learning. Enthusiasm and enthusiasm improve the effect and quality of dance creation and promote the stable and sustainable development of early childhood dance education in my country. Teaching dance on the basis of video teaching can not only help children develop a good form but also increase the physical and mental health of learning children, make children more comfortable, and improve their aesthetic level. In addition, the combination of online and offline teaching methods can inject more impetus into the development of aesthetic education.

Data Availability

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

Conflicts of Interest

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

References

- [1] J. Rudd, T. Buszard, S. Spittle, L. O' Callaghan, and L. Oppici, "Comparing the efficacy (RCT) of learning a dance choreography and practicing creative dance on improving executive functions and motor competence in 6–7 years old children," *Psychology of Sport and Exercise*, vol. 53, Article ID 101846, 2021.
- [2] N. A. Oparina, U. V. Nedelnitsyna, I. D. Levina, O. V. Maltseva, and M. G. Kaitandjyan, "Folk dance as a means of formation and creative education of primary school children personality," *PalArch's Journal of Archaeology of Egypt/Egyptology*, vol. 17, no. 6, pp. 731–742, 2020.

Retraction

Retracted: Application Model Construction of Traditional Cultural Elements in Illustration Design under Artificial Intelligence Background

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Shi, "Application Model Construction of Traditional Cultural Elements in Illustration Design under Artificial Intelligence Background," *Mobile Information Systems*, vol. 2022, Article ID 7412066, 9 pages, 2022.

Research Article

Application Model Construction of Traditional Cultural Elements in Illustration Design under Artificial Intelligence Background

Lei Shi 

Institute of Fine Arts, Changchun University, Changchun, Jilin 130000, China

Correspondence should be addressed to Lei Shi; shil@ccu.edu.cn

Received 30 April 2022; Revised 18 May 2022; Accepted 26 May 2022; Published 14 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Lei Shi. 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 sustainable development of modern illustration art needs to dig deep into traditional culture in content and, on the basis of spreading cultural forms and improving cultural influence, supplement its own creative forms. The influence of AI (artificial intelligence) on illustration design not only is manifested in the optimization of illustration design tools and the improvement of design efficiency, but also makes the illustration design methods more diverse and promotes new breakthroughs in the illustration design concept under the influence of new technologies. In this paper, combining the advantages of two activation functions, SoftSign and ReLU, a new activation function, SReLU, is constructed and applied to CNN (Convolutional Neural Network). The multimode property of color prediction is modeled by quantifying ab color channels in Lab color space, and the introduction of GAN (Generative Adversarial Network) structure can make the whole model show better generation effect and improve the generation ability of image style conversion network. *Results.* The experiment proves the effectiveness of the method with high-quality image visual effect.

1. Introduction

With the continuous development of social economy, the field of illustration began to focus on the flexibility of drawing form and content, turning illustration into a tool of expression, incorporating unique Chinese traditional elements, which made it have more aesthetic value. As a result, illustration design took on a new development face and became one of the manifestations of Chinese traditional elements. No matter whether the color matching is comfortable and eye-catching, this phenomenon begins to prove the arrival of the visual society, and the cultural industry that came into being has become the mainstream information industry in modern society. Design provides uncertainty and possibility for AI (artificial intelligence), while AI provides a new method to solve problems for design. Although it will take some time for AI to be widely used in all walks of life technically, it has already caused many discussions in the humanities, and the introduction of AI can bring

considerable application prospects to many industries [1]. However, the art development in the field of illustration needs to reinterpret the traditional cultural forms, so as to make them better carriers of Chinese cultural elements and reflect their own cultural values.

The history of illustration art is very long. Over the years, many different styles and forms of illustration works have appeared in the society, and gradually as a fashionable profession, they have quietly flourished. The domestic Illustrator China Network has gathered most of the local illustrators' works, the supply and demand of the illustration market, and so on. Vlacic has applied and innovated the local traditional cultural elements and figures and has a leading position in related research fields [2]. Through the detailed discussion of the importance of using traditional cultural elements in illustration creation, the reference points, the creation process, and the creation methods of traditional cultural elements, this paper strongly demonstrates the argument of "research on the application of traditional

cultural elements in illustration creation". Yang et al. analyzed the relationship between art design and AI, trying to find the balance between them [3]. By analyzing the influence of AI on art design, Zhang demonstrates that the combination of AI and art design can provide a more intelligent, stylized, and commercialized development path for future art design [4] with the promotion of the innovation of ideas and tools. Deng et al. discussed how to innovatively apply Chinese traditional cultural elements in contemporary illustration design and its application significance. Inject new vitality into Chinese contemporary illustration design and make it glow with vitality [5]. In view of the current situation of the domestic illustration industry, we should create a new illustration design style, such as reinterpreting the traditional Chinese culture, constantly developing diverse traditional cultural elements, and applying them innovatively, so as to complete the transformation of traditional cultural elements into commercial values [6].

AI also plays a role in the field of art generation. With the help of AI, artists' creative thinking can generate very specific works of art, such as painting works generated by deep learning algorithms and music composed by AI. These are all created by using computers as creative tools driven by our subjective consciousness. It is the combination of human creativity and human writing design codes. The creative inspiration generated by illustration design benefits more from its uncertainty, while the calculation process in which computers participate is more definite and stylized. Therefore, how to improve the design thinking of machines is one of the key points to promote the combination of AI and illustration design. In this paper, firstly, we understand the stylization principle of deep learning images from the reconstruction of CNN (Convolutional Neural Network). In stylization, we can adjust the weight ratio of content and style to get stylized images with different effects.

2. Related Work

2.1. The Development of Illustration Design. With the advent of the digital age, illustration has become a popular cultural trend and has been widely spread. Chen et al. can imitate the styles drawn by various brushes by using digital tools [7], but our aim is not to imitate but to master the characteristics of digital technology through a long-term attempt, so as to create more digital illustration identification bases with artistic value for us. Cassalho et al. [8] use the color mode on the computer to adjust the color tone and transparency of the picture, feel the rapidly changing colors and graphics, and feel the artistic effects presented to us from different angles by changing the picture composition, which greatly stimulates the creative desire and exploration spirit of digital illustrators [8]. Guo et al. [9] use 3D software and motion capture technology to depict people's facial expressions in detail, which is similar to but more expressive than photography [9]. Peng et al. [10] used hand-painting, images, and three-dimensional effects to create an elegant and long rhythm of virtual light, leaving viewers with a colorful imagination space [10]. Wu et al. [11] used spray paint or volatile pigments as tools to create graffiti on abandoned

walls, car bodies, bridge opening, passages, and telephone poles [11].

With the advent of the digital age and the convenience of information exchange, we can learn about the development of illustration art in different regions, different countries, and different cultures. Our illustrations have changed from ancient line drawing and woodcut to today's application of computer technology. The development of illustration in China requires us to develop students' creative thinking in the process of education. The lack of traditional culture makes us lose the cultural roots, and the traditional thinking mode can no longer attract the attention of the public in today's rapid development.

2.2. Research on Deep Learning in AI. Illustration design integrates knowledge from many fields. It contains both aesthetic expression and logical thinking in philosophical ideas, so it is not only the process of artists' creation, but also the process of logical thinking. AI-driven design is one of the issues being discussed in the art world. AI can help designers get rid of complicated design steps, save design time, and improve efficiency in some aspects.

Ayesha et al. [12] transformed ancient paintings into realistic natural images and put forward a novel solution to the problems caused by ancient paintings [12]. He et al. [13] proposed image style conversion based on CNN to increase multi-scale context loss [13]. In this paper, a stylized image is synthesized by constraining the high-level CNN features similar to content images and the low-level CNN features similar to style images. Badawy et al. [14] proposed a novel architecture for realizing extremely high-speed style conversion in feed-forward mode [14]. Perez-Borrero et al. [15] proposed a new method based on adaptive patch partitioning for local texture transfer, which can capture the style of the sample image and keep the structure of the source image [15].

Flah et al. [16] proposed a method that can estimate dense depth map from monocular image. In this method, a Zhang Quanjing focusing image is obtained from the multi-focusing image stack captured by the camera mounted on the mobile phone, and then the depth value on a certain focal plane can be calculated [16]. Wei et al. [17] put forward an unsupervised learning method that uses the reconstruction error of stereo image pairs as the loss function of CNN, so that CNN can train and predict the depth map without providing depth supervision information [17]. Cruz et al. [18] proposed an image texture extraction method with rotation invariance by using the eigenvalue of intensity gradient and multi-resolution analysis and used it for image retrieval [18]. Du et al. [19] proposed that deep learning technology can be applied to image texture extraction and gave a concrete model of style transfer network [19]. Thomas et al. [20] proposed a model of rapid style transfer network [20]. The network model is divided into generation network and loss network. The training and generation processes are separated. After training a certain style, the model is saved, the style rendering is performed later, and the trained model can be directly loaded.

3. Research Method

3.1. Illustration Image Classification. Based on art and culture and under the premise of folk production and living conditions, it has formed a conventional form of expression in the social environment. On the specific artistic form, artists and people will refine these cultural contents to form a complete artistic symbol. Chinese traditional culture pursues elegance and flatness and does not respect perspective and limitations in the realistic environment. Painters take this artistic conception and this so-called “beauty” as their main expression direction and goal.

In the process of combining illustration art with information technology, we constantly absorb various Chinese cultural elements to ensure that the value of illustration art itself begins to change to commercial value. As one of the four ancient civilizations, China has rich history and culture. Therefore, in the process of illustration art creation, it is necessary to vigorously develop diverse elements of Chinese traditional culture.

It provides a new design combination point for AI designers, gradually extends the traditional fixed concept of artistic creation, produces more diverse artistic creation ways, and gradually shifts from fixed mode to more diversified artistic thinking. In the color decoration, the forms of gradual strengthening, gradual weakening, transformation, repetition, rhythm, etc. are used. At the same time, the methods of harmony, fainting, and echoing are used to seek unity in the change of subject contrast, and the pictures are colorful and maintain overall harmony. Making use of the randomness of the machine algorithm interacts with people and jointly completes the creation of artistic works; the other does not require the direct participation of the artist so that the machine can understand the characteristics of the artist's works and use algorithms to generate works of art that conform to the artist's style. Theoretically speaking, it is a process of copying and reproduction, rather than complete creation.

Image classification is the basis of image understanding, and it is widely used in the field of computer vision, such as security, transportation, and Internet. Traditional image classification methods mostly use feature descriptors, but illustration images are more complicated than natural images, and the applicability of traditional image classification methods is poor. Therefore, this section puts forward the illustration image classification method based on CNN to verify the superiority of CNN in painting image classification.

Activation function is the key technology of CNN's development. Activation function introduces nonlinear elements to CNN, which makes CNN simulate the nonlinear distribution of sample data in real environment and solve the problems that linear models cannot solve. Combining the advantages of SoftSign and ReLU functions, a new activation function named SReLU is constructed. The activation function is defined as follows:

$$f(y_i) = \begin{cases} y_i, & y_i \geq 0, \\ a_c \text{SoftSign}(y_i), & y_i < 0, \end{cases} \quad (1)$$

where y_i is the input of the i th activation function f , the ReLU function value is taken when the input of the activation function layer is greater than 0, and the hyperbolic tangent function value is taken when it is less than 0. c represents different channels of picture colors, and a_c represents the values of different color channels, controlling the input of negative half axis.

The parameter a_c of the SReLU activation function can be back-propagated to be optimized, the parameter update follows the chain derivation rule, and the a_c gradient optimization is shown in the following formula:

$$\frac{\partial \varepsilon}{\partial a_c} = \sum_{y_i} \frac{\partial \varepsilon}{\partial f(y_i)} \frac{\partial f(y_i)}{\partial a_c}, \quad (2)$$

where ε represents the objective function and ∂a_c represents the gradient of the current layer.

According to the specific needs of this article, that is, according to the needs of illustration image classification, we redesigned the CNN structure. The CNN structure of this section is shown in Figure 1.

As shown in Figure 1, the network model designed in this section consists of 10 layers, with convolution and downsampling alternating three times, and finally two layers of full connection layers. The first and second pool layers are followed by LRN, and the first full connection layer is followed by Dropout.

Take the painting data set as an example; an image with a size of 225×225 is input from the input layer, the image size after the first convolution layer is 50×50 , the image size after the second convolution layer is 25×25 , and the image size after the last convolution layer is 8×8 .

3.2. Colorization of Illustration Images. Chinese traditional cultural elements are the overall representation of different ideological cultures and ideologies, nourished by more than 5,000 years of Chinese civilization. They reflect the features of the Chinese nation and constitute a national culture that people have gradually evolved into by combining their own thinking concepts, through life experience and continuous exploration and creation. For many service designs, such as interactive design, it is necessary to get the data of users' needs, preferences, and behaviors from big data and to mine, develop, and analyze the data of users' potential needs [18].

This can better analyze the user's interaction behavior and provide services for users. As a typical example of Chinese cultural characteristics, it has played an important historical role. Ink and wash art is not only in the art form of painting, but also integrated with calligraphy, seal cutting, Taoism, philosophical spirit, and other contents, being an important form of expression that gathers the core of Chinese traditional culture.

The origin of design is people's thinking problem, and it is people's cognitive problem about the use, classification, and functionality of such commodities. Generally speaking, it is an art that is close to the people and easily resonates with the public. After a long period of development, traditional

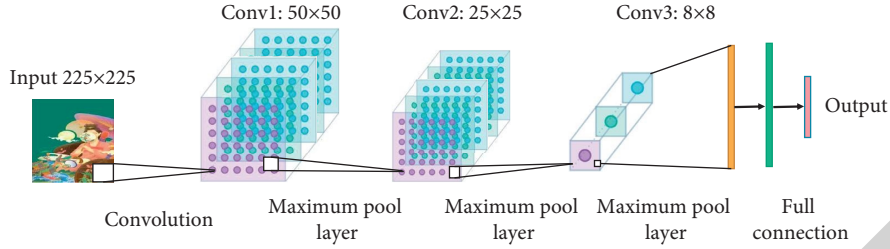


FIGURE 1: CNN structure design.

illustration has formed a variety of creative styles. On the basis of ink painting, we constantly learn from innovation, inherit Chinese traditional cultural elements, and, at the same time, make the products form a simplified ink illustration style and unique temperament [3].

Not only does the traditional coloring method of illustration images need manual intervention, which takes a long time and has poor coloring effect, but also the coloring speed decreases significantly with the increase of the size of the picture to be processed. Therefore, in recent years, the automatic colorization method of illustration images based on CNN has gradually replaced the traditional colorization method. The Euclidean distance between the color image generated by the network and the real color image is taken as the loss function. Because of the multimodal nature of color prediction, this loss function will lead to the average color of the model in many cases, which makes the whole image tend to brown tone.

Although regression seems to be suitable for this task due to the continuity of color space, in fact, the method based on classification may be better. Because color prediction is multimodal in nature, many objects can present a variety of possible colors. In this section, the probability distribution of possible colors of each pixel is predicted, and an automatic colorization algorithm is proposed. The algorithm uses the network structure as shown in Figure 2.

Distribution is trained from gray level input to quantized AB color value output. The model adopts a structure similar to VGG16 network, which contains 10 convolution groups; each convolution group contains 2 or 3 repeated convolution layers, the convolution kernel size is 5×5 , and there is a ReLU activation function behind each convolution layer.

In color prediction, this average effect will lead to desaturation of colored images. In addition, if a reasonable set of coloring is nonconvex, then the actual solution will not be in the set, thus giving an unreliable result.

Given the brightness input X , the probability distribution of possible colors of each pixel is obtained by mapping $\partial(\cdot)$ with CNN learning function:

$$\hat{Z} = \partial(X). \quad (3)$$

In order to compare the predicted color probability distribution \hat{Z} with the real color probability distribution Z , the function of converting the real color Y into the vector Z is defined as shown in the following formula:

$$Z = H_{gt}^{-1}(Y). \quad (4)$$

In this process, soft-encoding scheme [16] is used to find the five nearest neighbors of the true color $Y_{h,w}$ in the output space of 213 classes, and Gaussian weighting is carried out according to their distance to $Y_{h,w}$.

The last layer of this paper uses softmax classification function, which is the most used function in multi-classification tasks. In the field of reinforcement learning, softmax function is often used to convert a certain value into activation probability. In this case, softmax function becomes a function with temperature parameters. The formula is shown as follows:

$$\sigma_t(z)_j = \frac{\exp(z_j/T)}{\sum_{k=1}^K \exp(z_k/T)}, \quad \text{for } j = 1, 2, \dots, K, \quad (5)$$

where T is called the temperature parameter. When T is large, it tends to be positive infinity and the activation probabilities corresponding to all activation values tend to be the same (that is, the activation probabilities have little difference); When T is very low, i.e., tends to zero, the greater is the difference of activation probability corresponding to different activation values.

3.3. Image Stylized Model. The method of directly quoting traditional cultural elements in illustration creation does not mean directly copying but can be directly applied to some traditional cultural elements with beautiful forms and certain cultural connotations. To put it simply, it is to use the local traditional cultural elements and graphics as a whole, or it may be changed locally according to the needs of illustration creation and integrated into the creation of illustration works. This technique that transcends time and space needs to find the combination of traditional cultural elements and graphics and the form and content of illustration creation need to be expressed and cannot be combined arbitrarily.

Dynamic image stylization is to establish a new dynamic image stylization loss function by adding inter-frame loss function on top of the original image stylization loss function. By defining an instantaneous consistency between the two frames, the $i + 1$ frame and the stylized i frame are initialized, and the optical flow between the two frames is constrained to prevent jitter and jump.

Therefore, it is necessary to add the consistency penalty term to the loss function. In order to detect the moving

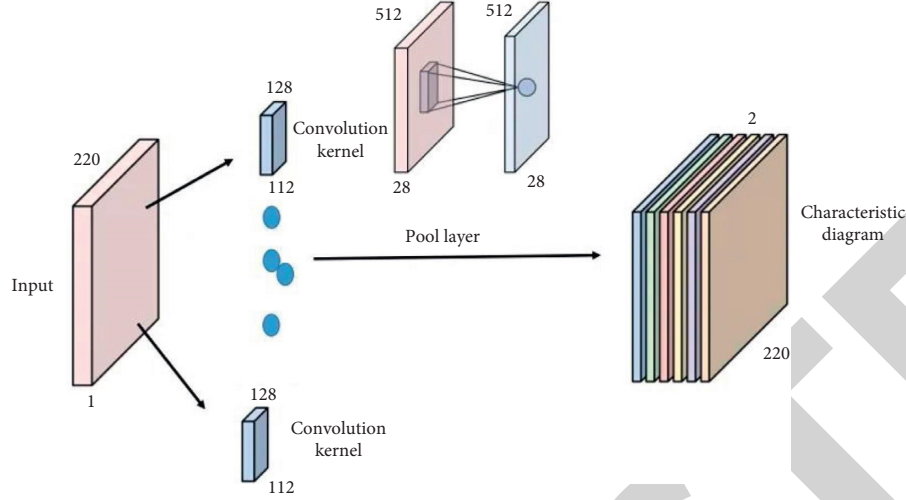


FIGURE 2: The network structure diagram of the algorithm in this section.

boundary in the two frames and the new area in the second frame, the consistency detection of the forward optical flow field and the backward optical flow field is used. The formula is as follows:

$$\tilde{w}(x, y) = w(x, y) + \tilde{w}(x, y), \quad (6)$$

where $w(x, y)$ is the optical flow field in the previous frame and $\tilde{w}(x, y)$ is the optical flow field in the next frame. The estimated second frame image is obtained by adding the forward optical flow field to the first frame because the second frame is changed from the first frame image by motion.

Although the style model with histogram matching layer can adapt to more style images, there is still much room for improvement in the quality of the stylized images generated by it. Therefore, in order to further improve the performance of the model, make the generated images more authentic, and make a reasonable quantitative evaluation of the generated paintings, this section decided to introduce GAN (Generative Adversarial Network) structure.

Based on the idea of antagonistic training, a GAN consists of two small networks competing with each other. This competitive mode helps the GAN to imitate any distribution of data. The ability of GAN to imitate data makes it like a machine artist. Once successfully trained, it can create artworks. By setting a reasonable loss function and then judging the texture characteristics of the image, the GAN establishes a mapping relationship between the noisy image and the denoised image, so as to achieve the purpose of image denoising and produce a clearer image.

The overall optimization objective function of GAN is as follows:

$$\min_G \max_D (D, G) = E_{x \sim P_{\text{data}}(x)}[(\log D(x))] + E_{z \sim P_g(z)}[(\log(1 - D(G(z))))]. \quad (7)$$

For generator G , the gradient ascending method is generally used for optimization, and for discriminator D , the gradient descending method is generally used for optimization.

The introduction of GAN in this section can ensure the retention of high-level information of content images provided in the data set, and color information and texture information of style images provided [19] as much as possible. The stylized model introduced into GAN retains the original module for solving content loss and style loss, which is also very important for the training of generator network. The model frame diagram of this section is shown in Figure 3.

In the whole model, the generator acts as an “information source” from which the discriminator obtains the original unlabeled data. Unmarked data is the key to improve the performance of discriminant model. Suppose the data categories are divided into 1, 2, and 3 cases. The discriminator calculates the probability that the input image is 1, 2, 3 and 3 categories.

To sum up, the discriminator needs to have three different training data sources:

- (1) The significance of the existence of real data with labels is to serve as a standard data distribution [14].
- (2) There is no real data of the label. For these data, the discriminator knows that these data are real.
- (3) Pictures from the generator are classified as false samples by the discriminator.

Gram matrix is also needed to define the style loss function and the specific formula is as follows:

$$l_{\text{style}}^{\phi, j}(\hat{y}, y) = \|G_j^{\phi}(\hat{y}) - G_j^{\phi}(y)\|_F^2, \quad (8)$$

where F is Frobenius norm, F-norm, which is a kind of matrix norm, and $G_j^{\phi}(x)$ is the Gram matrix of the activation value of image x in the j th layer of model ϕ and $G_j^{\phi}(x)$ is defined as follows:

$$G_j^{\phi}(x)_{c,c'} = \frac{1}{C_j H_j W_j} \sum_{h=1}^{H_j} \sum_{w=1}^{W_j} \phi(x)_{h,w,c} \phi_j(x)_{h,w,c'}, \quad (9)$$

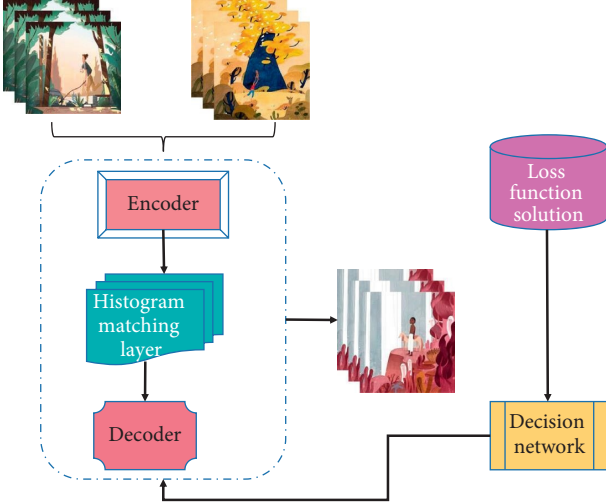


FIGURE 3: Model frame diagram.

where $G_j^\phi(x)_{c,c'}$ represents the Gram matrix correlation between the two channels of c, c' in the characteristic graph; $\phi_j(x)_{h,w,c'}$ represents the activation value of the j -layer (characteristic graph) of graph x in module ϕ ; and the height-width channel coordinates are the values of h, w, c position.

The total loss of fast style transfer network is defined as follows:

$$L_{\text{total}}(p, a, x) = \gamma_1 L_{\text{content}} + \gamma_2 L_{\text{style}}. \quad (10)$$

In the actual coding process, in order to simplify the calculation, the content loss function is usually calculated at only one layer in the network, while the style loss function is calculated at multiple network layers and then superimposed to take the average value.

4. Result Analysis

In order to verify that the activation function proposed in this section not only has certain advantages in the classification of painting data set (Data_A), but also is feasible in other data sets, the model proposed in this paper is applied to other general data sets (Data_B) for experiments.

In this paper, the best effect can be achieved when the negative semiaxis parameter $a_c = 1.5$ of the activation function SReLU is activated and the negative semiaxis coefficient of LeakyReLU is initialized to 1.5 according to experience. When using Tanh and SoftSign, the learning rate was set to 0.02, and the learning rate of other activation functions was set to 0.001; each experiment was performed for 1000 iterations. The experimental results are shown in Figure 4.

It can be seen that on Data_A, Tanh has the lowest accuracy, SoftSign has higher accuracy than Tanh and ReLU, and LeakyReLU has slightly higher accuracy than ReLU. However, the model constructed by the activation function SReLU used in this paper achieved the highest accuracy rate of 95.69%, which was 1.6% higher than that of ReLU, thus



FIGURE 4: Comparison results of activation function experiment.

proving the effectiveness of the activation function in this section applied to Data_A.

It is worth noting that under the same model parameters, the activation function Sigmoid's classification accuracy of Data_A is very low, so the experimental results of Sigmoid are not included in this experiment.

Taking Data_A as an example, we compare the convergence of the network model with the increase of the number of iterations of activation functions Tanh, SoftSign, ReLU, LeakyReLU, and SReLU. The experimental results are shown in Figure 5.

As shown in Figure 5, except for the activation function Tanh, all the activation functions are iterated about 2500 times and the network model tends to converge. It can be seen that SReLU obtains a higher classification effect without affecting the convergence performance of the model, which further proves its advantages.

Next, we compare the classification performance of this network model with that of the general network model on Data_A. The experimental results are shown in Table 1.

As can be seen from Table 1, compared with LeNet, the network model in this paper has great advantages, and its classification performance is slightly higher than that of AlexNet. It can be seen that the network model designed in this paper has certain advantages in Data_A and the improved activation function plays a certain role in improving the classification accuracy.

When there are many possible colors of objects in the gray scale picture, this loss function will encourage conservative prediction in order to minimize the loss, resulting in the average coloring effect of the overall brownish color. However, the algorithm proposed in this paper adopts the cross entropy loss of classification, and the coloring model can predict the probability distribution of possible colors of each pixel. In training, the classification rebalancing technique is used to emphasize the rare color categories, so that the network model can produce vivid, full, and colorful coloring effects. Figure 6 is a graph of loss function during the training of this experiment.

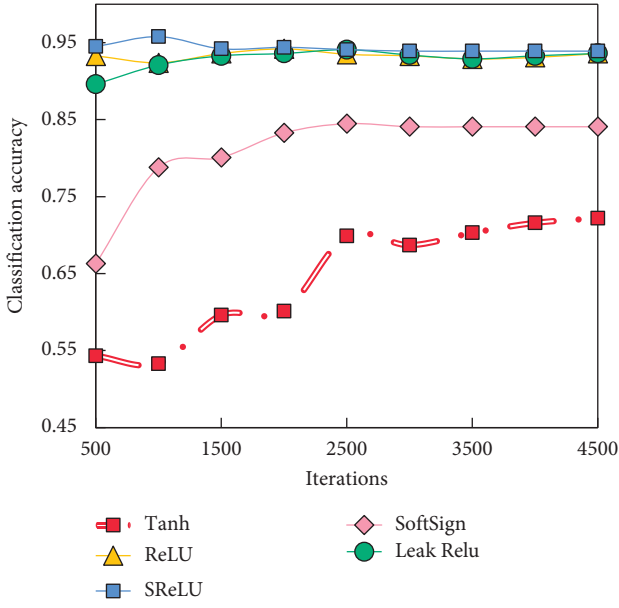


FIGURE 5: Comparison of convergence trends of activation functions on Data_A.

TABLE 1: Comparative results of different network model experiments.

| Model | Accuracy (%) |
|---------------------|--------------|
| Model of this paper | 96.63 |
| LeNet | 66.01 |
| AlexNet | 92.18 |

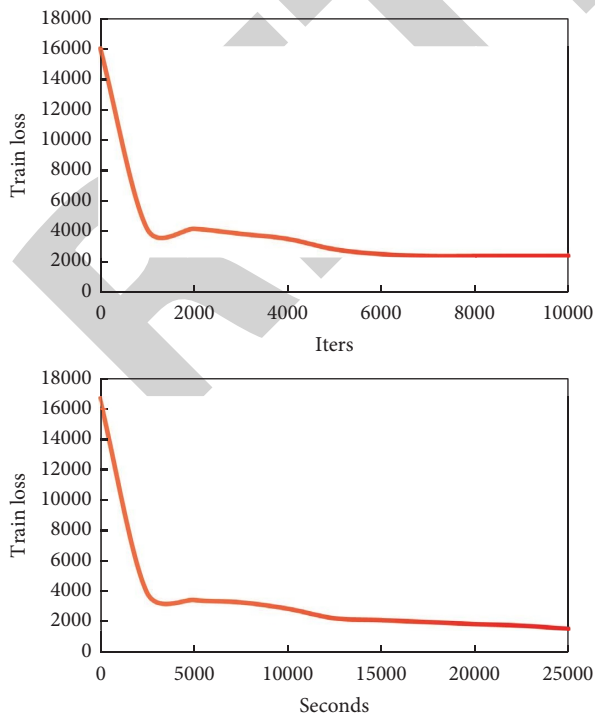


FIGURE 6: Model loss function curve.

Table 2 presents the analysis of illustration image colorization results of different algorithms under different indicators. The second column and the third column show the accuracy of the colored image and the original color image in different threshold distances, respectively. The fourth column shows the results of the coloring Turing test. For all indicators, the higher the result, the better.

It can be seen that when the threshold is set to 3%, the accuracy of the algorithm proposed in this section is 17.88%, which is higher than the 15.03% of the algorithm in [17] and 12.69% of the algorithm in [20].

When the threshold distance is extended to 5%, the accuracy of the algorithm proposed in this section reaches 39.62%, which is still higher than the 36.68% and 34.71% of [17] and [20], which shows that the color distribution in the coloring results in this paper is the closest to the original color.

The coloring result of the algorithm proposed in this paper accounts for 45.82% of the total score in the evaluation experiment, far exceeding the 25.41% of [17] and 28.91% of [20], which shows that the coloring result of the algorithm proposed in this section is closer to the real picture in terms of overall comfort and color distribution.

The experimental results prove that the algorithm proposed in this section can produce more convincing colorization results than the algorithms of [17] and [20].

There are two methods to judge the quality of stylized images, quantitative and qualitative. The qualitative method is to let the public judge which picture is better in quality from the visual angle of the public and select the best option in the public's mind. However, as far as quantitative methods are concerned, at present, there is no unified quantitative method to judge the stylized images after migration in the field of image stylization, because the probability distribution of images of each style is different; some are cartoon paintings, some are secondary paintings, and some are landscape paintings.

200 images produced by different models were taken and sent to the two classifiers for identification. Six groups of comparative experiments were conducted, and the experimental results are shown in Figure 7.

GAN style model, histogram matching style model, multi-style generation model for real-time transmission, instance normalization model, and adaptive style model are used in this comparative experiment. The figure shows that compared with other models, except for the first group of experiments, in which the GAN stylized model is poor, the stylized models based on the GAN show good generation performance. It also proves the feasibility and effectiveness of this method.

In this paper, the network is upsampled by deconvolution layer, and features are fused twice, which causes CNN to make full use of the local information of the underlying convolution features, thus processing the local details of its output depth map better. This training process can make CNN parameters find a better local minimum point. It can be seen from Figure 8 that this network structure and its training process make the prediction result of CNN in this paper obviously superior to that of [17].

TABLE 2: Analysis of colorization results of illustration images.

| Model | 3% accuracy | 5% accuracy | Visual authenticity (%) |
|---------------------|-------------|-------------|-------------------------|
| Model of this paper | 17.88 | 39.62 | 45.82 |
| Reference [17] | 15.03 | 36.68 | 25.41 |
| Reference [20] | 12.69 | 34.71 | 28.91 |

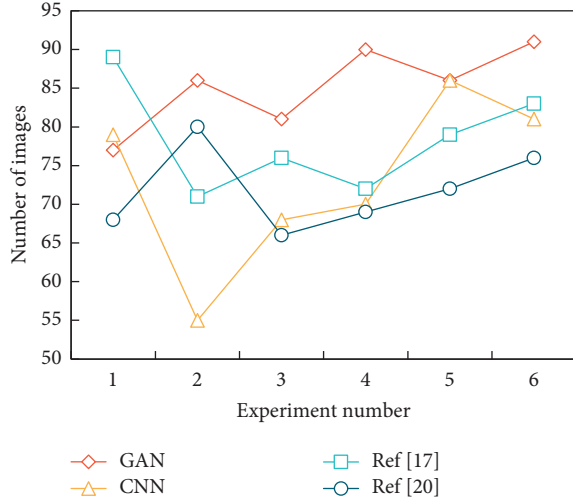


FIGURE 7: The number of images judged to be true.

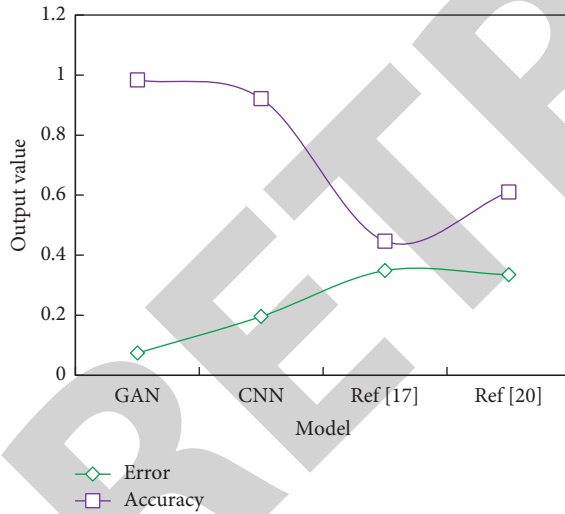


FIGURE 8: Comparison of experimental results.

Compared with other methods, this method has superior performance which is mainly due to the deeper and more complex network structure. The model avoids the super-pixel segmentation of the image and the inverse operation of large matrix in the prediction process, which not only retains the pixel-level accuracy of the image, but also makes the prediction process faster.

5. Conclusion

Different nationalities have different cultures, which is the most direct and obvious way to distinguish us from other

nationalities. Chinese traditional cultural elements with unique cultural qualities have laid the foundation of the splendid cultural treasure house of the Chinese nation. AI has a significant impact on the illustration design industry. The biggest benefit that AI brings to designers is that it can replace tedious and inefficient repetitive work and some established artistic expression methods. In this paper, based on SReLU's improved CNN model, the classification accuracy of Data_A is improved correspondingly. By quantifying the ab color channel of Lab color space, the coloring model can predict the probability distribution of ab value and select the most possible color distribution. Experiments show that the coloring results produced by the proposed algorithm are more dynamic and more real in perception. GAN is applied to the artistic model of a single model and multiple styles, which promotes better integration of different styles of pictures with the provided content pictures and generates better visual stylized pictures.

Data Availability

The figures and tables used to support the findings of this study are included in the article.

Conflicts of Interest

The author declares no conflicts of interest.

Acknowledgments

This work was supported by the "13th Five-Year Plan" of Jilin Provincial Education Department: "The Illustration Design Research on Brand Culture Strategy" (JJKH20200601SK) phased results.

References

- [1] J. Liu, Q. Chen, and X. Tian, "Illustration design model with clustering optimization genetic algorithm," *Complexity*, vol. 2021, no. 4, 10 pages, Article ID 6668929, 2021.
- [2] L. Vlacic, "The 2019 APEX award of excellence in the category of design & illustration? Covers goes to the IEEE? Intelligent transportation systems magazine [Editor's Column]," *IEEE Intelligent Transportation Systems Magazine*, vol. 11, no. 4, pp. 3-4, 2019.
- [3] W. Yang and X. Chi, "Cognition and design: selection of illustration style in native products packaging design based on neurocognitive science," *NeuroQuantology*, vol. 16, no. 6, pp. 385-390, 2018.
- [4] L. Zhang, "Illustration design teaching mode based on virtual wall painting technology," *International Journal of Emerging Technologies in Learning (ijET)*, vol. 14, no. 3, p. 190, 2019.
- [5] J. Deng and X. Chen, "Research on artificial intelligence interaction in computer-aided arts and crafts," *Mobile Information Systems*, vol. 2021, Article ID 5519257, 14 pages, 2021.
- [6] A. Mehndiratta and K. Asawa, "Non-goal oriented dialogue agents: state of the art, dataset, and evaluation," *Artificial Intelligence Review*, vol. 54, no. 1, pp. 329-357, 2021.
- [7] Z. Chen and Y. He, "Imitation or efficiency? aesthetics of artificial intelligence," *Foundations of Science*, vol. 26, no. 3, pp. 475-486, 2021.

Retraction

Retracted: English Writing Feedback Based on Online Automatic Evaluation in the Era of Big Data

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Li, "English Writing Feedback Based on Online Automatic Evaluation in the Era of Big Data," *Mobile Information Systems*, vol. 2022, no. 1, Article ID 9884273, 9 pages, 2022.

Research Article

English Writing Feedback Based on Online Automatic Evaluation in the Era of Big Data

Jing Li 

Foreign Language Department, Anhui Xinhua University, Hefei, Anhui 230088, China

Correspondence should be addressed to Jing Li; li_jing@axhu.edu.cn

Received 24 April 2022; Revised 17 May 2022; Accepted 19 May 2022; Published 9 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Jing Li. 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.

Under the influence of the continuous development of modern information technology, the online automatic evaluation system for English writing teaching was born in response to demand. The rise of the online automatic assessment and correction system has broken through the limitations of the campus, making English writing teaching no longer restricted by time and space. Adapting to the needs of English writing development in the era of big data, making full use of modern information technology to improve writing effect, further promoting the development of educational informatization and the transformation of writing teaching, and realizing the mutual blending and innovative development of education and information technology have become the inevitable trend of future development. This paper applies the combination of teacher feedback and automatic feedback to the teaching of English writing in senior high school and discusses whether the combination of the two can change the disadvantages of the automatic writing evaluation system and solve the problem of traditional single teacher evaluation. In this paper, the text feedback system is introduced into the context information, and the context information is used to filter the difference between the active context and the active context, so as to further reduce the number of participants in collaborative filtering and improve the real-time computing efficiency of the algorithm. By distinguishing dynamic text quality indicators from stable text quality indicators, this paper proposes a similar context-aware neighborhood model. Based on experimental analysis, the accuracy of feedback results is 45.2% higher than that of the original online automatic evaluation system.

1. Introduction

The continuous development of Internet technology promotes the arrival of big data and information age, brings more convenient means to language learning, and puts forward higher requirements for foreign language teaching [1]. There are three problems in the present situation of English writing teaching, the problems of the whole teaching, the problems of teachers' English writing teaching, and the problems of the author's English writing itself, and so is the present situation of junior high school English writing teaching. There are some problems in the whole situation, such as the tendency of writing to take exams, the insufficient teaching time of writing, and the lack of systematic teaching methods for writing teaching [2]. Comprehensive English learning needs to start from four dimensions: listening, speaking, reading, and writing.

Writing is the link between the author and the reader, creating an important platform for the exchange of ideas between the two sides. Therefore, writing can best reflect the author's comprehensive language application ability, so writing is an important aspect that can not be ignored in English learning [3]. With the rapid development of information technology and network technology, various information technology methods are gradually being used in course teaching in order to improve the teaching of English writing in high school, how to conduct automatic evaluation of English writing through online methods, so as to facilitate timely assessment of the author's English writing situation. Feedback and guidance have received more and more attention from domestic experts and scholars [4]. Writing teaching has always played an extremely important role in the development of the author's English professional quality. As one of the activities that can reflect the development of

the author's comprehensive English language ability, its quality will not only affect the development of the author's comprehensive language quality, but also affect teachers' evaluation of the author's English language level [5]. As the core of process teaching method, feedback has always been the focus of foreign language teaching research. With the progress of science and technology, a new type of feedback, that is, online automatic feedback, came into being [6]. From the perspective of the function of the automatic evaluation system, the automatic writing evaluation system gives suggestions for revision of the author's composition, and the author constantly revises and improves the first draft of the composition, thus producing a certain effect on the improvement of the author's writing level. Whether the system is suitable for the current situation of domestic writing teaching and whether it can improve the writing performance of writers at different levels are all issues worth exploring [7]. Compared with teacher feedback, online automatic feedback pays more attention to the author's language expression and spelling and grammar mistakes, while teacher feedback pays more attention to the structure and content of the author's composition. Compared with online automatic feedback, teacher feedback can improve the structure and content of the author's composition more effectively. While online automatic feedback can improve the grammar and language expression of the author more effectively [8]. Teacher feedback can not solve all the author's puzzles and difficulties, lack of personalized guidance, and the author's writing feedback, which is a big problem. English should vigorously promote the integration of the latest information technology and curriculum teaching and continue to give full play to the important role of modern educational technology, especially information technology in foreign language teaching [9]. English teachers should keep pace with the times and integrate and rationally use information technology elements in the specific classroom design and implementation process. Therefore, on the basis of traditional feedback methods, network feedback has also become a new feedback method that needs to be verified over time [10]. Technology synchronized with network feedback has also brought convenient big data analysis [11]. Questionnaire questions and comparative analysis of actual operation data through the Internet can not only solve social problems and commercial sales problems, but also show the trend of personal preference in the data, so as to achieve the purpose of people-oriented analysis [12]. Based on the above research, there is no good result of English writing feedback research on online automatic assessment and correction. Therefore, this paper proposes the following innovations, hoping to achieve breakthroughs in English writing feedback research on online automatic assessment and correction under the background of big data:

- ① This paper proposes to filter clusters by using context information. In many application scenarios, the context of the project has a great influence on scoring. Therefore, this paper introduces the context information into the text feedback system and uses the context information filtering, which is different

from the active context to further reduce the number of participants in collaborative filtering and improve the real-time operation efficiency of the algorithm.

- ② Based on this, the feedback model designed in this paper further combines the nearest neighbor model and the latent semantic model to obtain the best suggestions while considering similar effects. This model establishes a model-text-feedback structure for mining model, text and feedback information, and their relationship [13]. By distinguishing dynamic text quality indicators from stable text quality indicators, this paper proposes a similar context-aware neighborhood model.

The chapters of this paper are arranged as follows: the first chapter is the introduction, which discusses the background and significance of the topic selection and expounds the innovation of the article. The second chapter of this paper mainly combines the research results of domestic and foreign big data in the field of English writing feedback research on online automatic evaluation and correction and proposes innovative results and research ideas of this paper. The third chapter of this paper is the method part, which deeply discusses the application and principle of related algorithms, and based on the previous research results, combined with the innovation of this paper, a new online automatic evaluation and correction English writing feedback model is proposed. The fourth chapter of this paper mainly discusses the experimental part of the algorithm application. Through the experimental results, on the basis of sorting out the data, an optimization model is established. The fifth chapter is the conclusion, which summarizes the research results of this paper.

2. Related Work

Ponomarev et al.'s research on the application of automatic scoring technology mainly focuses on the research on the consistency with man-machine scoring and the research on assisting classroom writing teaching. The essence of the research on assisted classroom writing teaching is the research on whether the classroom writing teaching can achieve good results and whether the author's writing level can be improved [14]. Chong et al. proposed that the automatic evaluation system and teacher feedback can be combined to form a new feedback method, and then the respective advantages of the two feedback methods can be integrated. Writing teaching provides great help [15]. The interaction between teachers and students in the writing teaching of Done and Eun is not strong. From the arrangement of teachers' compositions to the grading of teachers, teachers are the main body, ignoring the role of the author's writing subject, which leads to the writing teaching focusing on the writing results rather than the process. The lack of writing training for authors, due to the limited time in senior high school, and writing is a slow and complicated task, and teachers often reduce the arrangement of writing tasks in order to save time, resulting in the lack of writing training for authors [16]. The research of Teixeira et al. and

others shows that, in the past, the more traditional way of English writing review is usually through paper correction, which brings a large teaching burden to English teachers. Due to the large number of authors, most teachers evaluate the overall image in the review process, and the review comments are not detailed enough, resulting in the fact that even if there are errors in the composition written by the author, they can not be corrected in time. Finally, it affects the improvement of the author's writing ability [17]. Flanagan and Hirokawa believe that, from the perspective of system theory, "teaching is a control system composed of four elements: teacher, author, teaching content, and teaching means. Only through feedback information can any system form a closed loop. It is possible to achieve effective control to achieve the goal [18]. Bucher et al. are the first people to explore, record, and verify computer-based writing assessment. Because of their pioneering research, they use regression model, taking the surface features of the text as the independent variable and the paper score as the dependent variable to measure the composition, without involving content, organization, genre, etc. [19]. An and Li believe that, in the process of internationalization of college teaching, English writing is gradually playing a more and more important role in college education and teaching. Reading English literature has almost become the basic requirement of college teaching, and English writing has gradually become the focus and difficulty that both authors and teachers attach great importance to in teaching [20]. Greene et al. proposed that the system throughput is not high enough to deal with a large number of program corrections in a short time. Using a network-based distributed automatic correction system, by using a distributed model, the correction tasks are assigned to each server in the evaluation server cluster, or the function of automatic parallel evaluation of the programs to be correctly distributed on the client computers in the local area network, significantly improving the efficiency of system correction [21]. Cao believes that it provides a practical path for English writing to improve research ability and decision support service quality. English writing demand-oriented intelligent data service model and service capability evaluation system can not only optimize the process of English writing research activities, but also provide new channels and practical paths to improve the research capability, output efficiency, and service quality of English writing and also provide reference for libraries and information institutions to systematically recognize the realization method or application path of intelligent data service model in the era of big data [22]. Han's research results show that the main function of big data collection layer is to collect data related to interest and service characteristics of the client, server, and agent. It includes service requests, logs, service scores, and service description information provided by service providers, such as service annotations and service functions. These data grow rapidly and have various types and low value density, so they are called "service big data" [23,24]. The research of Utomo shows that the development of technology has made the scoring validity of the intelligent review system more and more reliable. The application of the system in the classroom

can reduce the teacher's correction burden and improve the author's autonomous learning ability and learning efficiency [twenty-four]. Pearson believes that the traditional mobile education application has some problems, such as high equipment cost, low network transmission speed, and lack of educational resources. The emergence of mobile cloud technology effectively makes up for the above-mentioned defects [25]. Piotrowska et al. and others proposed that ACM/ICPC system can only give right or wrong results and can not simulate manual correction to comprehensively score all aspects of the program. For a program that fails to pass the compilation of syntax errors and a program that will run errors only under specific conditions, the system gives the correction results of errors, and there is no detailed error reason, which greatly affects the author's programming enthusiasm [26]. The research of Gill and Khehra is based on statistical analysis of a large number of texts. LSA obtains a high-dimensional English semantic space, and words and paragraphs are represented as vectors in this semantic space. Comparing essays with known writing quality, their similarity is measured by the cosine of the included angle in the English semantic space [27].

On the basis of the above-mentioned research, this paper confirms the positive role of big data in the research field of English writing feedback of online automatic correction, constructs a genetic algorithm model combining various algorithms, makes in-depth analysis and research on the acquired and collected data by using big data algorithm, makes more effective use of the data, mines the valuable knowledge hidden behind the data, and finds out the potential problems in the research of online automatic correction of English writing feedback.

3. Methodology

3.1. Research on Related Theories

3.1.1. English Writing in the Context of Big Data. In English writing, the author is often in a state of uncertainty and self-confidence in his grammar control and word use. In particular, he hopes that the teacher can give detailed comments and modifications. Authors generally expect targeted corrections in English writing and can give more personalized evaluations based on different problems in their writing. Although teacher feedback is not as efficient and fast as online feedback, as a feedback method for forming habits in long-term education and teaching, the author's acceptance and credibility are also the highest. The advantage of online grading is not only that it can save valuable time, but also that the instant feedback realized by new technology has a positive impact on learning. In the traditional teaching mode, due to the pressure of large class teaching, many writing teachers are difficult to provide immediate and effective feedback, and the evaluation of composition is often a mere formality. The use of automatic writing evaluation system can enable teachers and students to realize real-time communication, discuss problems at the first time, and give feedback in time. The main function of the automatic evaluation system is to revise the English composition.

Within the specified time, the author can make unlimited revisions to his composition and then submit it for continuous output. Compared with the traditional teaching mode, after the application of the automatic evaluation system, not only the top students and the middle students are willing to write, but also the class participation of low-level authors will be improved, thus promoting the common progress of authors at different levels. Figure 1 is an example of a general data model structure.

The service logs corresponding to different times are different, the name of the called service (MapImage) and the service operation (GetMap) used when calling the service.

3.1.2. Research and Analysis of Online Automatic Evaluation and Correction. The reliability of the model refers to the probability that the model will run without failure in the specified operating environment and within the specified time. That is to say, the running results of the model must be consistent with the required functions and the design objectives. In the development stage of the program, it is impossible to imagine all English text input. This requires the design and development to consider the processing of illegal English text input and be able to judge whether the current program state is abnormal. In case of exception, the model can return to the normal state by calling exception processing. In the development process of the system in this paper, for each executable part, an appropriate data sample set is designed to test whether the correction result of this part meets the expectations. This can effectively reduce the probability of bugs in the system operation and greatly ensure the correctness of the system. Generally, the similarity problem occurs when correcting English compositions, which is also a common problem in the same kind of writing. Based on big data, this paper selects the nearest neighbor screening method to screen the text content. Generally, two samples with the same service are called neighbor relations, which is extremely common in the original sample-standard matrix. When two samples meet the following two constraints at the same time, they are called the nearest neighbor relationship:

$$\sigma(\text{Sim}(u_i, u_j)) > \varepsilon, \quad (1)$$

where $0 < \varepsilon < 1$.

$$\forall \text{Sim}(u_i, u_j)_k, \quad (2)$$

including $1 \leq k \leq K$. $\text{Sim}(u_i, u_j)$ represents the similarity between two samples, and $\sigma(x)$ is used to further map the similarity to the $(0, 1)$ interval. A parameter ε ($0 < \varepsilon < 1$) is introduced into the model to remove neighbors not greater than ε in the sample text. The typical value of ε can be 0 or 0.1, etc. $\text{Sim}(u_i, u_j)_k$ is the u_i largest similarity value after calculating the similarity value between k and all its neighbors. Obviously, the asymmetric neighbor relationship makes $\text{Sim}(u_i, u_j)_k$ and $\text{Sim}(u_j, u_i)_k$ have different meanings. The expression at this time is

$$N(s_i) = \{s_j | \sigma(\text{Sim}(s_i, s_j)) > \varepsilon, 1 \leq k \leq K\}. \quad (3)$$

Therefore, when the nearest neighbor selection method is satisfied, the expression relationship between them is

$$u_{i,k} \longrightarrow u_i \text{ or } u_j \longrightarrow u_i. \quad (4)$$

Using the above formula, this paper constructs the adjacency matrix as shown in Figure 2. The method of selecting the nearest neighbor according to the parameter ε will obviously meet the needs of actually correcting the article, so as to avoid the problem of repetition or similar unrecognizable.

The online English composition system that supports correction adopts the currently popular three-tier architecture based on B/S and performs hierarchical processing on the system, so that each layer is relatively independent, and changes in each layer will not cause other layers to be too large. The change fully reflects the encapsulation characteristics of object-oriented programming and provides convenience for adding system functions and expanding the system. The three-tier structure of this system is interface layer, transaction logic layer, and data access layer. Automatic writing evaluation system is a feedback way to judge and score learners' writing by using modern computer technology under the guidance of constructivist learning theory and process writing theory. Figure 3 shows the basic framework of the three-tier architecture.

Multiple feedback theory can also be called multiple feedback teaching method, which contains many theoretical viewpoints in different teaching methods, so multiple feedback theory is a comprehensive theory. The multiple feedback theory started early abroad and has been applied to various industries. Thomas et al. published an article on the application of the multiple feedback model to teaching. From this point of view, the multiple feedback theory has been recognized and valued by Western countries. At the same time, it is not only in education. It has also made great achievements in medicine and sports. Paying attention to the author's writing process in writing is an important stage to effectively improve the author's writing level. Under the background of traditional teaching, teacher feedback has been recognized by most authors, but under the background of the rapid development of contemporary education, teacher feedback has exposed many problems, for example, first, the efficiency of teacher feedback. At present, the teaching tasks of senior high school English teachers are complex, and the time for teachers to correct their compositions is limited. Usually, the author has blurred the content he once wrote, and his interest in revising has decreased. The basic principles of process writing theory are author-centered, focusing on the writing process, and emphasizing the development of the author's ability. Both the design of writing instruction and the arrangement of writing tasks are author-centered. At the same time, unlike other theories that focus on results, this theory focuses on the author's writing process and content. Finally, this theory also focuses on cultivating the author's ability to revise repeatedly, and the ability to think creatively.

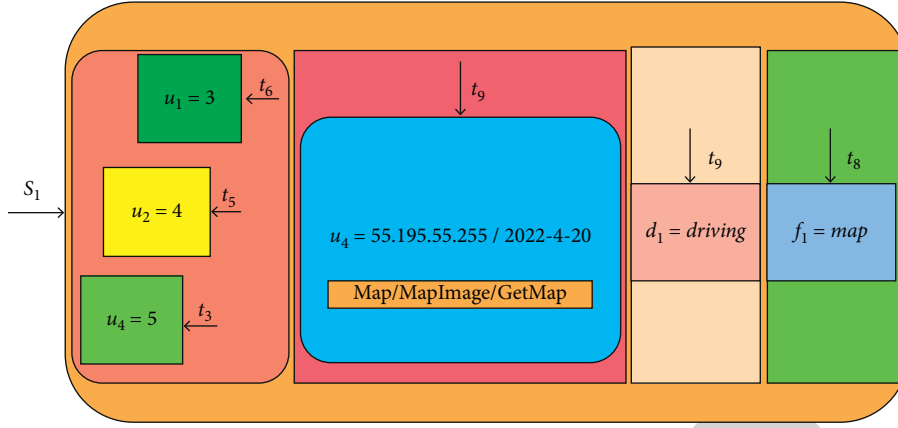


FIGURE 1: General data model structure example diagram.

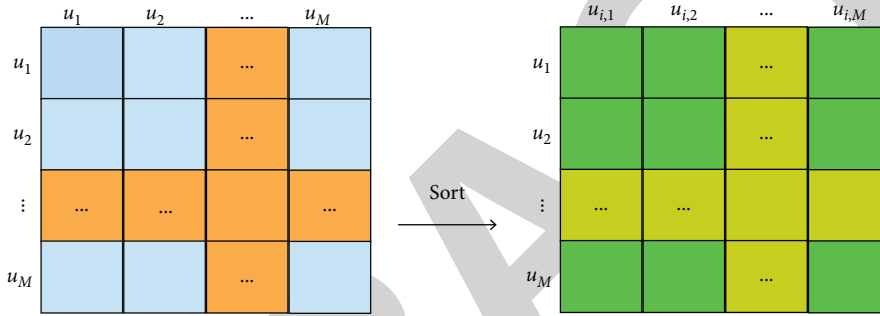


FIGURE 2: Adjacency matrix basic model diagram.

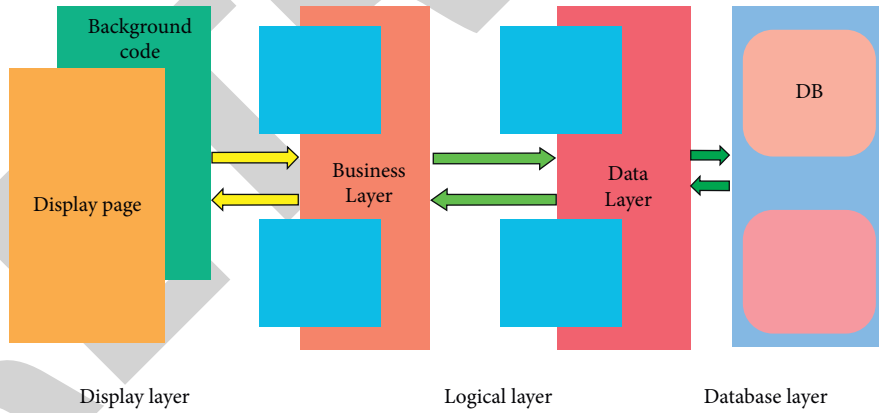


FIGURE 3: The basic framework of the three-tier architecture.

3.2. Research on Algorithm of Feedback System Based on Big Data. In this paper, Jaccard similarity coefficient is used to calculate the tag similarity between services. Jaccard similarity coefficient is an index to measure the similarity of two sets, which is defined as the proportion of intersection elements of two sets in their union. Jaccard similarity coefficient has intuitive meaning: when there are no same elements in the tag stem set of two services, the tag similarity is 0; if all elements in the set are the same, the label similarity is 1. The formula for calculating the label similarity between

services s_i, s_j based on the Jaccard similarity coefficient is as follows:

$$T_sim_{i,j} = \frac{|T'_i \cap T'_j|}{|T'_i \cup T'_j|}. \quad (5)$$

in which T'_i, T'_j are the tag stem set of services s_i, s_j . When $|T'_i \cap T'_j|$ is larger, the greater the tag similarity s_i, s_j between services $T_sim_{i,j}$, that is, the more repeated elements in the tag stem set of s_i, s_j , and the greater the tag similarity

between them. It is a factor to ensure that the label similarity is within the $[0, 1]$ range. If there are no identical elements in the text sets of the two services, the text similarity is 0. If all elements in the set are the same, then we have the following:

$$F_sim_{i,j} = \frac{|F'_i \cap F'_j|}{|F'_i \cup F'_j|} \quad (6)$$

The feature similarity between services s_i, s_j is synthesized by the weighted addition of its label similarity and text similarity. The calculation method is as follows:

$$C_sim_{i,j} = \alpha \times T_sim_{i,j} + \beta \times F_sim_{i,j}. \quad (7)$$

In the above formula, $\alpha \in [0, 1]$ is the weight of label similarity, $\beta \in [0, 1]$ is the weight of text similarity, and there are $\alpha + \beta = 1$. At this time, it can be ensured that the feature similarity $C_sim_{i,j}$ will still be within the range of $[0, 1]$, where the weight value represents the relative importance of tag similarity and text similarity.

Among the model-based collaborative filtering methods, the implicit meaning model and its approximate model are the most typical representatives. This series of models realizes the calculation process of traditional singular value matrix decomposition based on Quasi-Newton method. After filling the data of the original sparse matrix, it is expressed as the product of simple matrix. The general expression is as follows:

$$\begin{aligned} R &\longrightarrow (Fill) \longrightarrow R' \longrightarrow R' \\ &= U^T S V \longrightarrow R' f \\ &= U^T S_f V_f. \end{aligned} \quad (8)$$

Obviously, in the above calculation, it is necessary to strictly control the data filling in the process of data processing. As online automatic evaluation is generally concentrated in a certain period of time, it is impossible for the general model to bear the complexity and data processing in the corresponding time. Matrix analysis is a basic method of hidden semantic model, which is easy to realize. Its characteristic is to infer the text scoring mode through the attribute set of text and model. Both the model and the text are mapped to the same dimension of the semantic space. Each model is associated with a vector and the vector of each text j , and then, the model text interaction is modeled as the feature in the space and predicted by the score of the model i text j . The expression looks like this:

$$\begin{aligned} \hat{T}_{ij} &= p_i^T q_j, \\ &= \sum_{g=1}^f p_{ig} q_{jg}. \end{aligned} \quad (9)$$

The above model is based on the basic singular value decomposition (SVD) method, where f is the influencing factor between model setting preference and text features. On this basis, the evaluation can be regarded as an advanced vocabulary input model, resulting in an advanced vocabulary set B_i , where $w_{i,j}$ is the B_i word in j . The frequency of calculating $w_{i,j}$ for this purpose is as follows:

$$tf(w_{i,j}) = \frac{N(w_{i,j}, B_i)}{|B_i|}, \quad (10)$$

where $N(w_{i,j}, B_i)$ is the number of times, $w_{i,j}$ appears in B_i , and $|B_i|$ is the number of all words in B_i . The reviewer can judge the quality of the article according to the frequency and number of words written by the reviewer. In reviewing an article, the author should be a participant and collaborator of the review feedback. The online composition review system should start from the author's learning effect and learning experience, not only paying attention to the author's mastery of language knowledge and skills, but also making the author experience progress and build self-confidence in the writing process through evaluation and feedback.

4. Result Analysis and Discussion

Based on the above analysis and research, this paper proposes to establish an online automatic feedback model of English writing evaluation based on big data. In order to test the scientificity, feasibility, and accuracy of the model, this paper will analyze the model from the aspects of the average error reduction rate of text processing, the filtering efficiency of interference items, the text analysis efficiency, the feedback effect optimization rate, and the feedback result accuracy and reliability. A1, A2, and A3 ($A1 > A2 > A3$) are selected as the experimental samples of three different English composition sample sets in terms of average error and interference filtering efficiency. The experimental analysis diagrams are shown in Figures 4 and 5.

In the two indicators of the above analysis, it can be seen that the average error reduction rate and the filtering efficiency of interference term fluctuate greatly. This is due to the index error caused by the data processing concentration, but from the point of view of the average error reduction rate, the reduction of the evaluation error by the model is obvious. Although the reduction rate is different for different number of sample sets, according to the experiment, it is basically stable at 63.4%; this is a fairly high error reduction rate, which can avoid most of the evaluation errors and biases caused by the model itself. On the analysis of the filtering efficiency of interference terms, it can be observed that an intersection point is obviously between the interval 3-4. Because the three sample sets selected in this paper have a quantitative relationship $A1 > A2 > A3$, but in that quantity, there is the filtering efficiency of the same interference item. This is because the filtering algorithm is embedded in the model, and the same interference item will be directly extended to other sample sets. Therefore, for any set of three sample sets, as long as this occurs, the same interference item in the subsequent modified sample set will be filtered directly, no more calculations. Therefore, the filtering efficiency of interference items can be improved to 60.7%. Let C1 and C2 be the two text sets in terms of text analysis efficiency, feedback effect optimization rate, and feedback result accuracy, and the advanced vocabulary and sentences



FIGURE 4: Analysis of average error reduction rate.

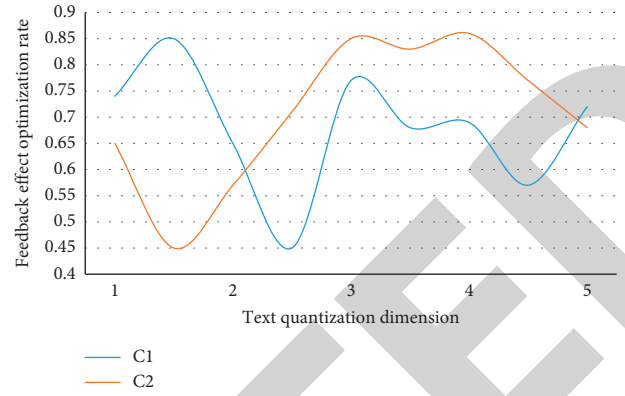


FIGURE 7: Analysis of feedback effect optimization rate.

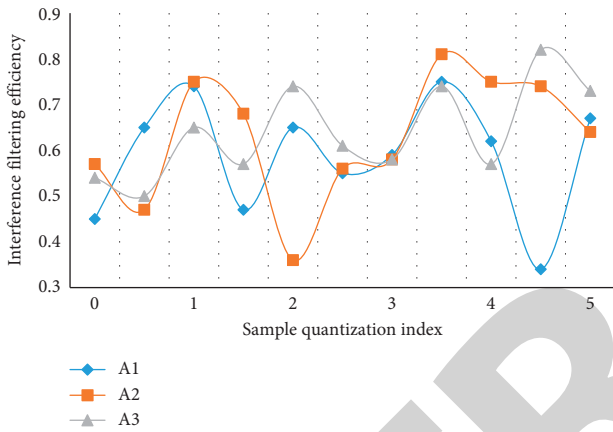


FIGURE 5: Analysis of filtering efficiency of interference items.

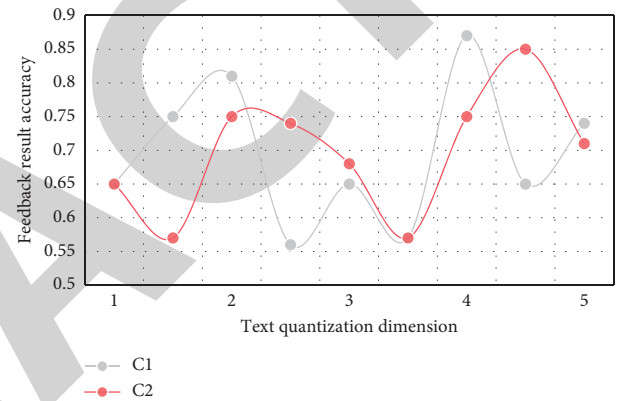


FIGURE 8: Analysis of the accuracy of feedback results.

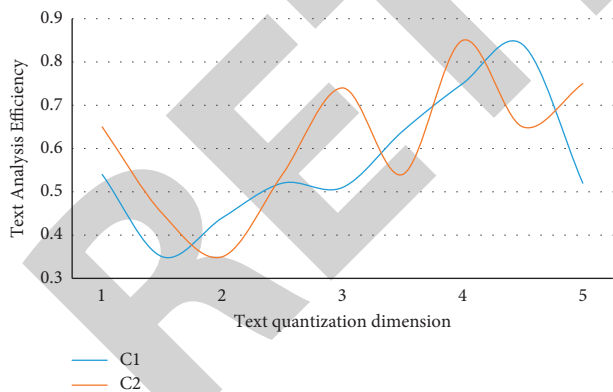


FIGURE 6: Text analysis efficiency analysis.

in C1 are lower than the frequency in C2. The data graphs of its analysis are shown in Figures 6–8.

By comparing the above three parameters, it can be found that the processing capacity of the model remains basically stable on different measurement axes, and in most cases, it maintains the same increase or decrease trend in the sample set, which is extremely important for a feedback system. This is even more evident in the analysis efficiency of the text. Although C2 appears to fluctuate slightly in

magnitude, the overall trend remains the same as C1. In the feedback effect optimization rate, under the data of multiple experiments, it can be obtained that the feedback effect of the online automatic evaluation and modification model is above 40% under normal circumstances and is stable at about 66.8%. On this basis, the accuracy of feedback results is also guaranteed, which reflects the effect of feedback content. The experimental results show that the accuracy of feedback results fluctuates around the average line of 68.9% in the experiment, which is 45.2% higher than the original online automatic evaluation system.

5. Conclusions

This paper has carried out research based on big data by applying the automatic English composition evaluation system to English writing evaluation. The purpose of this paper is to explore the current situation of model feedback in English writing teaching, the effect of the application of automatic evaluation system in English writing teaching, and whether the application of automatic evaluation system in English writing teaching can improve the author's writing level and learning motivation. At present, the online automatic evaluation and correction system is still in the stage of man-machine coupling. If, in a standardized test, a model rater is used to replace one of the necessary human raters,

the essay will be flagged and forwarded to another human rater for further evaluation; if the model disagrees with the human rater, then it can not only ensure the quality of scoring, but also improve the efficiency of scoring. Moreover, the relationship between model feedback and author's participation is not a one-way causal relationship, but a cyclical interactive relationship under the interaction of multiple factors. In the process of interaction between the two, the ultimate goal of model feedback is not to promote the author's participation, but to promote the participation of the author's cognition, emotion, and behavior as an intermediary and to improve the author's English writing ability. However, according to the experiment, the error reduction rate of the model is basically stable at 63.4%, and the feedback effect of the online automatic evaluation model is more than 40%, stable at about 66.8%. The accuracy of feedback results is 45.2% higher than that of the original online automatic evaluation system.

Data Availability

The figures data used to support the findings of this study are included in the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

The authors would like to show sincere thanks to those techniques who have contributed to this research. Anhui Xinhua University Quality Project: The Construction and Implementation Path of Ideological and Political Teaching System of College English Course from the Perspective of Three-in-one Education (Grant no. 2021szjy004).

References

- [1] X. Zhang and X. Ge, "Research on feedback mechanism of English writing teaching based on big data technology," *Boletín Técnico/Technical Bulletin*, vol. 55, no. 10, pp. 582–587, 2017.
- [2] A. M. Azmi, M. F. Al-Jouie, and M. Hussain, "Aae – a," *Information Processing & Management*, vol. 56, no. 5, pp. 1736–1752, 2019.
- [3] Y. Luo and Y. Liu, "Comparison between peer feedback and automated feedback in college English writing: a case study," *Open Journal of Modern Linguistics*, vol. 07, pp. 197–215, 2017.
- [4] A. Kaehne, "Big Data and what it means for evaluating integrated care programmes," *Journal of Integrated Care*, vol. 27, no. 3, pp. 249–258, 2019.
- [5] R. Qian, Z. Duan, and Y. Qi, "Stability of a general class of power control algorithms with single-step feedback in wireless networks," *IEEE Transactions on Automatic Control*, vol. 64, no. 7, pp. 2890–2897, 2019.
- [6] Z. Song, "Investigating Chinese EFL college students' writing through the web-automatic writing evaluation program," *English Language and Literature Studies*, vol. 9, no. 3, p. 20, 2019.
- [7] Y. Park, "Automatic evaluation of elementary school English writing based on recurrent neural network language model," *Journal of the Korean Association of Information Education*, vol. 21, no. 2, pp. 161–169, 2017.
- [8] Y. J. Lee, "Effect of automated writing evaluation feedback on Korean university students' revision behavior," *Foreign Languages Education*, vol. 27, no. 4, pp. 1–22, 2020.
- [9] G. M. A. Grami, "An evaluation of online and automated English writing assistants: collocations and idioms checkers," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 15, p. 218, 2020.
- [10] A. Petroni, H. L. Ko, T. Im et al., "A simple frequency-domain negative acknowledgment feedback for automatic repeat on reQuest underwater acoustic networks," *IEEE Journal of Oceanic Engineering*, vol. 44, no. 1, pp. 269–281, 2019.
- [11] A. Bauhofer and C. Daraio, "Neural networks for trajectory evaluation in direct laser writing," *International Journal of Advanced Manufacturing Technology*, vol. 107, no. 5–6, pp. 2563–2577, 2020.
- [12] J. Gao, "Exploring the feedback quality of an automated writing evaluation system p," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 16, no. 11, p. 322, 2021.
- [13] W. Du, J. Xu, and J. Zhang, "The development and construction of automatic English writing evaluation system from the perspective of functional grammar," *Revista de la Facultad de Ingeniería*, vol. 32, no. 6, pp. 335–340, 2017.
- [14] A. Ponomarev, Z. Chen, and H. T. Zhang, "Discrete-time predictor feedback for consensus of m systems with d," *IEEE Transactions on Automatic Control*, vol. 63, no. 2, pp. 498–504, 2018.
- [15] W. Chong, S. Rudkin, and J. Zhang, "Gender differentials and implicit feedback on online video content: enhancing user interest evaluation," *Industrial Management and Data Systems*, vol. 119, no. 5, pp. 1128–1146, 2019.
- [16] E. C. Dong and Y. Eun, "Global chartwise feedback linearization of the quadcopter with a thrust positivity preserving dynamic extension," *IEEE Transactions On Automatic Control*, vol. 62, no. 9, pp. 4747–4752, 2017.
- [17] L. A. Teixeira, N. Maia Azzi, J. Á de Oliveira, C. Ribeiro de Souza, L. da Silva Rezende, and D. Boari Coelho, *European Journal of Neuroscience*, vol. 51, no. 10, pp. 2023–2032, 2020.
- [18] B. Flanagan and S. Hirokawa, "An automatic method to extract online foreign language learner writing error characteristics," *International Journal of Distance Education Technologies*, vol. 16, no. 4, pp. 15–30, 2018.
- [19] D. Bucher, F. Mangili, C. Bonesana, D. Jonietz, F. Cellina, and M. Raubal, "Demo Abstract: e," *Computer Science - Research and Development*, vol. 33, no. 1–2, pp. 267–268, 2018.
- [20] S. An and Y. Li, "Multi-dimensional English automatic writing relying on multi type scenario information points of interest," *Revista de la Facultad de Ingeniería*, vol. 32, no. 10, pp. 854–862, 2017.
- [21] A. Greene, M. Elmer, S. Ludlam et al., "Evaluation of the content validity and cross-cultural validity of the study participant feedback questionnaire (SPFQ)," *Therapeutic Innovation & Regulatory Science*, vol. 54, no. 6, pp. 1522–1533, 2020.
- [22] J. Cao, "A cultural and functional approach to the assessment of logical thinking ability in English writing," *Scientific Programming*, vol. 2021, no. 1, Article ID 1783384, 9 pages, 2021.
- [23] Y. Han, "Educational resource online evaluation system based on neural network dynamic feedback algorithm," *Journal of Intelligent and Fuzzy Systems*, vol. 38, no. 2, pp. 1–13, 2020.

Retraction

Retracted: The Macroreform of the Electronics Manufacturing Industry under the Industry 4.0 Wave Based on Financial Performance Indicators

Mobile Information Systems

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

Copyright © 2023 Mobile Information Systems. 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. Wen, "The Macroreform of the Electronics Manufacturing Industry under the Industry 4.0 Wave Based on Financial Performance Indicators," *Mobile Information Systems*, vol. 2022, Article ID 6436112, 7 pages, 2022.

Research Article

The Macroreform of the Electronics Manufacturing Industry under the Industry 4.0 Wave Based on Financial Performance Indicators

Yixian Wen 

School of Business, Hunan Institute of Technology, 18Henghua Road, Zhuhui District 421002, Hunan, China

Correspondence should be addressed to Yixian Wen; wenyixian@hnit.edu.cn

Received 26 April 2022; Revised 12 May 2022; Accepted 16 May 2022; Published 3 June 2022

Academic Editor: Amit Gupta

Copyright © 2022 Yixian Wen. 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 study uses financial indicators dismantled by DuPont's identity as evidence to invert the resource allocation of top companies in the electronics manufacturing industry and then delineates their strategic groups through factor analysis and cluster analysis. Also, the timeline is divided into two periods: from 2010 to 2013 and from 2014 to 2017. The impact of Industry 4.0 was determined by studying and comparing the strategic groups of top companies in these two periods. It is confirmed that the competitive environment in the electronics manufacturing industry did change in the period after the rollout of Industry 4.0, with the general trend being in capacity. In the late Industry 4.0 period, there was an increase in the number of top-performing companies in the group of companies whose competitive strategies were based on production management and supply chain management capabilities. Companies that invest more resources in fixed assets are able to use digitization, networking, and automation. Companies that achieve greater efficiency in their own factory's production facilities can reap more benefits and widen the gap with their competitors.

1. Introduction

Industry 4.0 is a very hot topic in recent years. Whether it is news media, newspapers and magazines, corporate executives, and politicians, all of them are chanting Industry 4.0 intelligent manufacturing. However, some people are also questioning whether this is another wave of hype. In the hype cycle chart for emerging technologies in 2018, the IoT Platform, virtual assistants, and augmented reality that are required by Industry 4.0 in the public slogans are included. The technology to be included in the downward trend stage needs to wait. Does this imply that the bubble of Industry 4.0 is coming?

In the field of electronics manufacturing, the life cycle of production equipment and test instruments is very long. Unlike general consumer products, which are updated for several generations in just one year, there are equipment and instruments with a life cycle of five to ten or even twenty years [1]. Therefore, industry changes are not so rapid. In the

face of the impact of Industry 4.0, there may be no major short-term changes, but in fact, companies seem to be slowly changing.

In the past few years, for Industry 4.0, many large and small manufacturing conferences, forums, and exhibitions have been held all over the world. At the same time, many academic units and companies have also participated in industry 4.0-related research, adding R&D centers (such as Smart factory OWL, a research center for intelligent production systems, was jointly developed by Fraunhofer Research Institute and OWL University in Germany) or industrial applications (such as digital enterprise software suite and Siemens' comprehensive industrial software suite) [2–4]. But looking at their research topics, we can find that most of them are focused on specific topics in certain fields, such as cloud computing, industrial wireless networks, ERP systems, technology integration, virtual reality engineering, company strategies, and the use of big data [5]. Therefore, this study observes the changes in the

entire Industry 4.0 and electronics manufacturing industries from a wide range of perspectives [6].

2. Industry Introduction

2.1. Review of Industrial Development. In the manufacturing sector, advances in science and technology are driving the development of industrialization around the world. Although there is no universally accepted definition of the composition of each industrial revolution, from the perspective of technological development, the first three stages are generally accepted to distinguish:

- (1) develop water and steam-powered mechanical manufacturing facilities to break through the limitations of manpower and animal power
- (2) electricity as power and dismantling manpower for mass production
- (3) use electronic devices and information technology (IT) to support further automation of manufacturing

The main milestone of automation devices used in the third industrial revolution was the invention of the “programmable logic controller (PLC).” In 1978, the National Electrical Manufacturers Association (NEMA) defined a programmable controller as an electronic device that operates with numbers. It uses a programmable memory to store instructions, such as logic, sequence, timing, counting, and calculations [7, 8].

In short, PLC is an electronic system specially designed for applications in an industrial environment. It has the advantages of easy use, flexible design, and saving wiring manpower, so it is suitable for use in various control systems in industrial environments, as the core control task in automation control [9].

In the past 20 years, the actual labor force in the world's major industrial countries has grown rapidly, but now it has entered a bottleneck period. From the perspective of actual labor productivity in the United States, Germany, Britain, Japan, Italy, Canada, and France, excluding the depression caused by the financial tsunami in 2008 has now reached a level, which represents that, during the third industrial revolution, factory automation systems, such as programmable logic controllers (PLC), distributed control systems (DCS), and other functions that bring industrial production efficiency, are almost exhausted [10].

2.2. Definition and Scope of Industry 4.0. According to the economist Carlota Perez's understanding of the technological revolution cycle, a new technology will have a life cycle. Compared with the industrial technology that had a main axis in the previous three industrial revolutions, the general-purpose technology of the fourth industrial revolution (General-Purpose Technologies) is still being explored, and many studies are exploring this technology, such as the Internet of Things (IoT), Cyber-Physical Systems (CPS), and artificial intelligence (AI), but there is still no recognized standard technology, which is one of the reasons

why the public has different opinions on Industry 4.0 [11–13].

In 2018, the China Industry 4.0 Research Institute put forward the criteria for judging the fourth industrial revolution as “highly automated, highly networked, and highly digitized.” Each has its own technical field. Automation lies in hardware equipment supplemented by artificial intelligence (AI). To help with the operation, networking lies in the establishment of communication facilities, such as the Internet of Things (IoT) and 5G; digitalization lies in the internal information systems of enterprises, such as Big Data and artificial intelligence (AI). When these three items are complete, the development of intelligence is shown in Figure 1.

2.3. Electronics Manufacturing Industry. The electronics manufacturing field is one of the Taiwan's key industries. It has a history of nearly 50 years. The government led the introduction of semiconductor technology around 1970 and then promoted the PC assembly and standardization of peripheral components and accumulated OEM/ODM manufacturing and R&D, the process of which is shown in Figure 2. Experience has gradually nurtured an ecological chain in the electronics industry. Since the components of the electronics industry are diversified and require many different technologies to be combined, the clustering effect is very important. Taiwan has formed a high-level group in the electronics manufacturing field through the foundation laid in the early days. The convergence effect, in turn, occupies a key position in the global electronics industry [14].

Electronic product manufacturers, such as Hon Hai, Delta, when producing products, not only themselves but also production equipment and measuring instruments, can complete the entire production process. Measuring instruments can check the produced products, provide objective measurement standards, and eliminate defective products. The birth of a new high-tech product is bound to be matched with a compatible precision instrument, such as the Galaxy Note launched by Samsung Electronics in 2016. After the advent of smartphones, explosions occurred in various parts of the world because of the rapid development of mobile phone batteries, but no measuring instruments and standards suitable for testing were found, resulting in failure to catch defective products [15, 16].

In the Industry 3.0 era, electronic product manufacturers, automation equipment, and measuring instruments are closely linked to each other to complete part of the automated manufacturing, but at this time, most of the equipment and instruments are doing their own work and taking care of their own parts.

In the next Industry 4.0 era, the primary goal is to use the network (physical connection or 5G communication) to connect production equipment, measuring instruments, and control hosts. At the same time, by adding some data capture or sensors to the production equipment to learn the current operating status of the equipment in real time, proactive protection can be achieved, that is, through real-time data analysis to know whether the equipment is

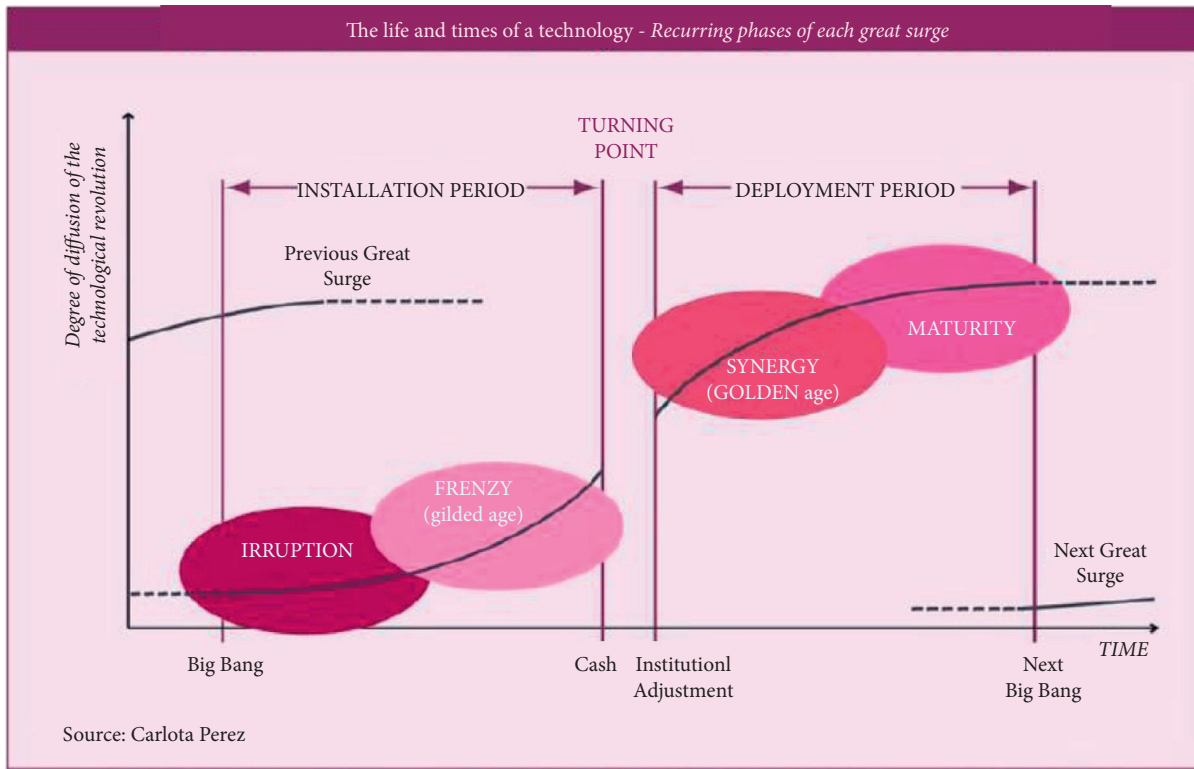


FIGURE 1: Analysis of Carlota Perez's technological revolution cycle.

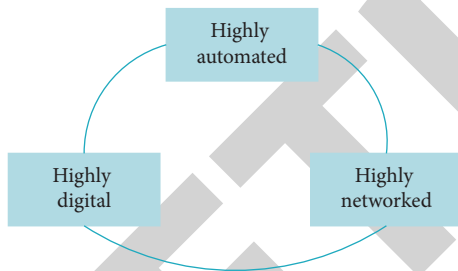


FIGURE 2: Characteristics of the fourth industrial revolution.

damaged [17]. It can improve the efficiency of operation while maintaining a safe working environment. Semi-conductors are upstream suppliers, and they are also manufacturers of electronic components, and they will also be included in the network.

When the network (Network) layer is completed, smart (Smart) is shown in Figure 3. Artificial intelligence and cloud services can integrate the information of the entire production process and feedback given by distributors to achieve better productivity.

Intelligent manufacturing technology is a technology that governments and industries around the world are gradually paying attention [18–20]. The following is a

chronology of the national development strategies proposed by various governments for intelligent manufacturing:

- (1) In 2011, the US government initiated a series of national-level discussions and recommendations on the “Advanced Manufacturing Partnership” to ensure that the United States can lead the next manufacturing industry.
- (2) In 2012, the German government adopted the “High Tech Strategy 2020” action plan, which sets out to provide billions of euros each year to develop cutting-edge technologies and at the same time incorporate Industry 4.0 into ten future projects.
- (3) In 2013, the French government launched a strategic review called “La Nouvelle France Industrielle” to define France’s industrial policy priorities.
- (4) In 2013, the British government proposed a long-term blueprint for manufacturing until 2050, which is called “the future of manufacturing.”
- (5) In 2014, under the framework of a public-private partnership, the European Union convened proposals for the “Factory of the Future” and “Permanent Processing Industry” to help develop and deploy the necessary key technologies to support the EU’s wide range of manufacturing industries.

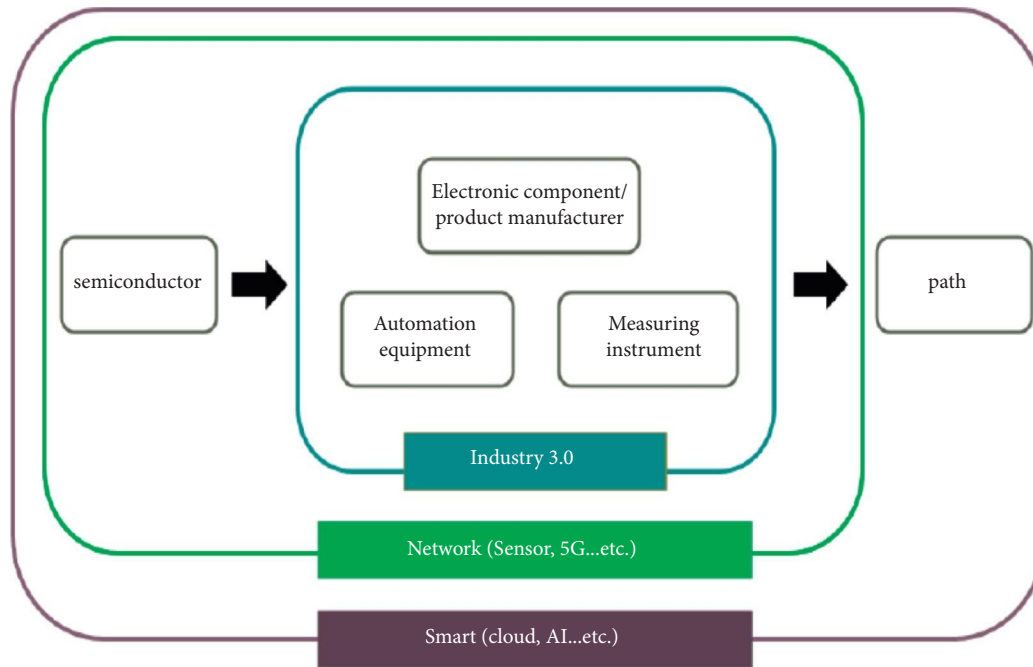


FIGURE 3: Conceptual diagram of the electronics manufacturing industry.

- (6) 2014, the South Korean government announced “Manufacturing Innovation 3.0,” emphasizing the strategy and task of promoting a new leap in South Korean manufacturing.
- (7) 2015, the Chinese government released the “Made in China 2025” strategy and the “Internet +” plan. It gives priority to ten areas of manufacturing to accelerate China’s informatization and industrialization.
- (8) In 2015, the Japanese government adopted the “Fifth Basic Plan for Science and Technology (2016–2020),” which paid special attention to the “Super Intelligent Society” that creates a new value in the direction of future industrial innovation and social change.
- (9) In 2016, Singapore launched the 6th “Research, Innovation, and Entrepreneurship 2020 Plan,” which clearly announced that it would invest \$19 billion. The four main strategies implemented include advanced, manufacturing, technology, and engineering.
- (10) In 2018, the US government issued the “Strategy for American Leadership in Advanced Manufacturing,” which continued the advanced manufacturing strategy promoted by the Obama administration.

2.3.1. Measuring Instruments. Measuring instruments are instruments used to detect, observe, and calculate various physical quantities and material components. They are mainly used in the field of electronics manufacturing for two purposes: when developing products, measuring

instruments are needed to confirm the material and performance of new products etc. When producing products, measuring instruments are needed to confirm the quality and safety of products. Measuring instruments are the cornerstone of industrialization [21].

Globally, with the continuous improvement of the industrial technology level, the rapid development of the information industry, and the increasing consumer demand for electronic products, the market for measuring instruments has also developed to a certain scale. According to Technavio, by 2021, the global electronic test and the measurement instrument market is expected to reach 23 billion U.S. dollars, mainly using semiconductors and other electronic components most commonly found in Asian manufacturers [22].

The demand for measurement instruments is driven by the growth of industries, such as electronics and semiconductor manufacturing, telecommunications, aerospace, and defense. The profitability of each company depends on controlling manufacturing costs and maintaining continuous and rapid product innovation. Large companies enjoy economies of scale in sourcing parts and product distribution, and small companies can compete by focusing on equipment in niche markets or developing a reputation for high-quality products. This industry is quite concentrated. In the United States, the revenue of the 50 largest instrument companies in 2018 accounted for about 70% of the overall instrument industry [23].

2.4. Semiconductor. Integrated circuit (IC) was invented in 1958. It is a major invention in the field of electronics manufacturing. It is indispensable for 3C products such as mobile phones, home appliances, and automobiles. Now,

TABLE 1: Preliminary narrative statistical analysis.

| Financial indicator | Early stage (2010~2013) | | | | | | |
|---|-------------------------|---------|--------|----------|--------------------|----------|----------|
| | Average | Minimum | Max | Variance | Standard deviation | Skewness | Kurtosis |
| Return on invested capital (ROIC) | 0.206 | 0.131 | 0.495 | 0.004 | 0.063 | 1.906 | 4.716 |
| Accounts receivable turnover rate | 5.759 | 1.457 | 34.160 | 16.425 | 4.053 | 3.828 | 21.452 |
| Accounts payable turnover rate | 13.254 | 3.330 | 61.558 | 91.219 | 9.551 | 2.308 | 6.756 |
| Inventory turnover | 8.622 | 2.246 | 57.125 | 40.883 | 6.394 | 4.309 | 28.191 |
| Turnover rate of fixed assets | 5.704 | 0.769 | 80.257 | 81.603 | 9.033 | 5.848 | 41.887 |
| Cost of goods sold/net sales | 0.572 | 0.242 | 0.899 | 0.025 | 0.158 | 0.011 | -0.681 |
| R&D expenses/net sales | 0.050 | -0.001 | 0.231 | 0.003 | 0.057 | 1.192 | 0.591 |
| Selling and administrative expenses/net sales | 0.187 | 0.017 | 0.427 | 0.012 | 0.108 | 0.456 | -1.008 |
| Depreciation and amortization/net sales | 0.033 | 0.003 | 0.244 | 0.001 | 0.030 | 3.766 | 22.042 |
| Business income tax/net sales | 0.030 | -0.049 | 0.115 | 0.001 | 0.024 | 0.726 | 2.105 |

TABLE 2: Postdescriptive statistical analysis.

| Financial indicator | Late (2014~2017) | | | | | | |
|---|------------------|---------|--------|----------|--------------------|----------|----------|
| | Average | Minimum | Max | Variance | Standard deviation | Skewness | Kurtosis |
| Return on invested capital (ROIC) | 0.191 | 0.106 | 0.617 | 0.006 | 0.079 | 2.637 | 9.401 |
| Accounts receivable turnover rate | 5.437 | 1.076 | 25.643 | 8.105 | 2.847 | 3.305 | 20.608 |
| Accounts payable turnover rate | 14.101 | 1.839 | 51.521 | 88.346 | 9.399 | 1.566 | 2.744 |
| Inventory turnover | 7.970 | 2.554 | 24.945 | 17.208 | 4.148 | 1.699 | 3.315 |
| Turnover rate of fixed assets | 5.157 | 0.523 | 59.745 | 69.757 | 8.352 | 5.102 | 29.441 |
| Cost of goods sold/net sales | 0.566 | 0.199 | 0.950 | 0.025 | 0.158 | -0.052 | -0.329 |
| R&D expenses/net sales | 0.065 | 0.000 | 0.246 | 0.004 | 0.061 | 1.135 | 0.793 |
| Selling and administrative expenses/net sales | 0.180 | 0.025 | 0.643 | 0.013 | 0.116 | 1.088 | 1.382 |
| Depreciation and amortization/net sales | 0.038 | 0.001 | 0.257 | 0.001 | 0.035 | 3.296 | 15.681 |
| Business income tax/net sales | 0.030 | -0.029 | 0.117 | 0.001 | 0.023 | 0.806 | 1.915 |

TABLE 3: Descriptive statistical analysis and comparison.

| Financial indicator | The rate of change in the later period relative to the previous period | | | | | | |
|---|--|---------|------|----------|--------------------|----------|----------|
| | Average | Minimum | Max | Variance | Standard deviation | Skewness | Kurtosis |
| Return on invested capital (ROIC) | -7% | -19% | 25% | 57% | 25% | 38% | 99% |
| Accounts receivable turnover rate | -6% | -26% | -25% | -51% | -30% | -14% | -4% |
| Accounts payable turnover rate | 6% | -45% | -16% | -3% | -2% | -32% | -59% |
| Inventory turnover | -8% | 14% | -56% | -58% | -35% | -61% | -88% |
| Turnover rate of fixed assets | -10% | -32% | -26% | -15% | -8% | -13% | -30% |
| Cost of goods sold/net sales | 1% | -18% | 6% | 1% | 0% | -557% | -52% |
| R&D expenses/net sales | 31% | -100% | 7% | 15% | 7% | -5% | 34% |
| Selling and administrative expenses/net sales | -4% | 47% | 50% | 14% | 7% | 139% | -237% |
| Depreciation and amortization/net sales | 18% | -63% | 5% | 42% | 19% | -12% | -29% |
| Business income tax/net sales | 0% | -40% | 2% | -3% | -2% | 11% | -9% |

one of the drivers of the rapid evolution of electronic technology is IC. As the IC industry continues to produce smaller and faster chips and the applicable fields continue to expand, IC can be said to be the source of all electronic products.

The IC industry leads the continuous technological innovation in the field of electronics manufacturing, and Taiwan, as an important town in semiconductor design and manufacturing, has a complete upstream, midstream, and downstream industry chain. At the same time, it has established IC design, IC manufacturing, IC packaging, and testing foundry models. Professional division of labor is used

to accelerate semiconductor R&D and production efficiency and to promote the vigorous development of the integrated circuit industry worldwide.

In 2019, affected by the Sino-US trade war, coupled with the slowdown in global smartphone sales growth, the semiconductor industry's market challenges have increased. However, with the gradual progress of AI, 5G, and other technologies, the semiconductor industry will only be able to face different technologies. The integrated design challenges of functions are generally expected to be just around the corner for the explosive growth of the semiconductor industry.

3. Research Results

In this study, the four industries of factory equipment/components, measuring instruments, electronic products, and semiconductors are divided according to the time interval from 2010 to 2013 (early period) and 2014 to 2017 (late period). The top 30 companies are taken in ROIC. A total of 120 companies will be taken in each period.

A narrative statistical analysis of the financial indicators of these companies was performed. The narrative statistical analysis results include average, minimum, maximum, variation, standard error, and skewness.

Kurtosis (skewness): Tables 1 to 3 compares the changes of various financial indicators in these two periods before and after. By narrating the results of statistical analysis and comparison, we can understand the differences between the high-performance companies in the electronics manufacturing industry and the previous high-performance companies from the data side:

- (1) The average value of ROIC in the later period decreased by 7%, the variance increased by 57%, the maximum value increased by 25%, and the minimum value decreased by 19%. This may be due to the addition of new competitors and changes in the environment. Front-end companies are challenged. Some companies can maintain excellent performance and continue to grow, and some companies have begun to decline in performance.
- (2) accounts receivable turnover rate, accounts payable turnover rate, inventory turnover rate, and fixed asset turnover rate show the capital leverage application (capital leverage) of the enterprise. The variance number is decreasing, which means the degree of dispersion is shrinking, showing that the application of capital leverage by top enterprises in the later period tends to be similar.
- (3) The average ratio of late R&D expenses to net sales was increased by 31%, while the variance difference was 15%, indicating that the dispersion of the company's R&D expenses to the net sales ratio increased and thus the overall R&D. The increase in costs shows that the importance of R&D and innovation in the electronics manufacturing industry is increasing, which is also in line with the intelligent development trend mentioned in Industry 4.0.
- (4) In the later period, the average turnover rate of fixed assets decreased by 10%, while the average ratio of depreciation and amortization to net sales increased by 18%. Generally, the capital invested in the machinery and equipment and other activities is relatively large, that is, commonly known as asset-heavy enterprises. The ratio of period depreciation to net sales is relatively high, while the ratio of fixed asset turnover rate is relatively low. From this point, it can

be estimated that there are more asset-heavy players in the top enterprises in the later period than in the early period.

- (5) The late skewness is positive skewness except for the cost of goods sold/net sales, that is, the right skewness, the tail on the right is longer, and the main body of the distribution is concentrated on the left. Although the cost of goods sold/net sales is negative skewness, the value is very close to 0. It can be seen that, in addition to the cost of goods sold/net sales, the remaining financial indicators, that is, the corresponding corporate capabilities, will have outliers business exists.

4. Conclusion

This study analyzes the strategic changes and growth trends of companies with high performance in the electronics manufacturing industry during the two periods from 2010 to 2013 and 2014 to 2017. From the research results gradually obtained in the analysis process of this research to make an overall summary, the research conclusions of this research can be divided into the following key points.

Industry 4.0 is not just a slogan: the ecology of top companies in the electronics manufacturing industry has indeed changed during the Industry 4.0 period. This research is based on the Industry 4.0 slogans from 2010 to 2013 in the early period and from 2014 to 2017 in the later period. In these two periods, the four major industrial equipment/components, measuring instruments, electronic products, and semiconductors related to Industry 4.0 in the field of electronics manufacturing industry, a study of 120 companies with 30 excellent front-end operations found strong evidence that the ecology of top companies is changing. It can be clearly seen from Figure 1 that, in the Industry 4.0 era, the major trend is production capacity.

This study uses the financial indicators dismantled by the DuPont identity as evidence to invert the resource allocation of top companies in the electronics manufacturing industry and outline their strategic groups through factor and cluster analysis. The impact of Industry 4.0 was determined by studying and comparing the strategic groups of top companies in these two periods. Companies that invest more resources in fixed assets are able to use digitization, networking, and automation. Companies that achieve greater efficiency in the production facilities of their own factories can gain more and widen the gap with their competitors.

The analysis results of narrative statistics show that the ratio of companies with good performance in the later stage of betting on R&D increased by 31% on average compared with the previous stage, showing a significant increase. At the same time, with the analysis of changes in the previous and late strategy groups, it can be seen that the smart asset strategy groups with high research and development in the early stage have a good chance of maintaining good performance in the later stage. This shows the importance of technology and innovation in the Industry 4.0 era. If a